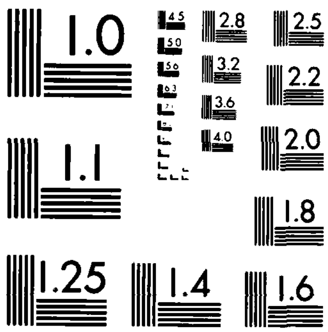
AD-A156 721 INSTALLATION RESTORATION PROGRAM PHASE II PROBLEM CONFIRMATION AND QUANTI..(U) RESEARCH TRIANGLE INST RESEARCH TRIANGLE PARK NC JAN 85 F33615-80-D-4000 1/2

UNCLASSIFIED F/G 8/8 NL



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963 A

INSTALLATION RESTORATION PROGRAM

PHASE II
PROBLEM CONFIRMATION AND QUANTIFICATION

MYRTLE BEACH AIR FORCE BASE,
SOUTH CAROLINA

VOLUME 2
Appendices

Prepared by

Center for Environmental Measurements
Research Triangle Institute
Research Triangle Park, North Carolina 27709

and

Geraghty and Miller, Inc.
844 West Street
Annapolis, Maryland 21401

Air Force Contract F33615-80-D-4000

Prepared for

Occupational and Environmental Health Laboratory
United States Air Force
Brooks Air Force Base, Texas

Revised
January, 1985

64

VOLUME 2

LIST OF APPENDICES

APPENDIX A

ANALYTICAL PROCEDURES UTILIZED IN GROUNDWATER SAMPLE ANALYSES

The groundwater samples collected from the wells at Myrtle Beach Air Force Base were analyzed for all or some of a variety of parameters. Included were pH, specific conductivity, total organic carbon (TOC), total organic halides (TOX), anions, metals, phenol and select volatile organic compounds. The volatile organic compounds measured included the following:

- o Benzene
- o Toluene
- o Ethylbenzene
- o Chloroform
- o Chloroethane
- o Methylene chloride
- o 1,2-Dichloroethane
- o 1,2-trans-Dichloroethylene
- o Chlorobenzene
- o 1,1-Dichloroethane

The procedures used for the analyses of these parameters are presented below. The detection limits for these procedures are presented in a table at the end of this section. The analytical results of the analyses are presented in Appendix G.

(1) pH - The pH of each groundwater sample collected was measured both in the field and the laboratory. The pH measurements at RTI were performed using a Corning Model

125 pH meter with a Fisher combination pH electrode. The measurements were made at room temperature and Fisher pH standards were used for calibration. Quality control included using all due care to avoid contamination, regular recalibration, and quality assurance checks using EPA-supplied audit samples.

(2) Specific Conductivity - The specific conductivity of each groundwater sample was measured using a Sybron/Branstead conductivity meter (Model PM-70CB). Standards were prepared by appropriate dilution of laboratory-prepared KCl solutions. Quality control included using very special care to avoid contamination, regular recalibration and quality assurance checks using EPA-supplied audit samples.

(3) Total Organic Carbon (TOC) - The total organic carbon was determined with an Oceanography International Model 0524C Total Organic Carbon Analyzer equipped with a Horiba Model PIR 2000 infrared analyzer. The samples were digested (oxidized) with potassium persulfate in a sealed ampule. The CO_2 resulting from oxidation of the organic species was then released and measured using the infrared analyzer. A quality control measure used was the oxidation of different volumes of the water samples in order to optimize the CO_2 measurement.

(4) Total Organic Halides (TOX) - The TOX measurements for the groundwater samples were determined using a Dohrmann Model DX-20 total organic analyzer. The procedure involves collection of the halocarbons on a bed of sorbent carbon and then thermal oxidation of the bed to produce chloride which is measured coulometrically. A blank was run with each set of four samples and the instrument was calibrated with a standard of 2,3,5-trichlorophenol before each sample run.

(5) Anions - The anions determined were sulfate, nitrate, chloride and bicarbonate. These were determined using a Dionex System Model 14 ion chromatograph. This system separates the anions using high performance ion exchange chromatography and measures them using a conductometric detector. Quality control measures performed include regular recalibration and analysis of quality assurance check samples provided by the EPA.

(6) Metals - The drinking water standard metals (iron, manganese, sodium, arsenic, barium, chromium, lead, mercury, zinc, selenium, and vanadium) were determined in the samples initially collected. Select samples collected during a repeat sampling effort were analyzed only for calcium, magnesium, sodium and potassium. All the metals were analyzed using flame or flameless atomization atomic absorption spectrometry. A Perkin-Elmer

Model 601 spectrometer was used and all procedures were taken from the EPA's water and waste water analysis manual. Quality control measures included regular recalibration and analysis of quality assurance samples from the EPA and the National Bureau of Standards.

(7) Phenol - Phenol was determined in the groundwater samples using EPA Method 420.1. In the procedure, phenolic materials are reacted with 4-aminoantipyrine in the presence of potassium ferricyanide at a pH of 10 to form a stable reddish-brown colored antipyrine dye. The amount of color produced is a function of the concentration of phenolic material. Laboratory-prepared quality assurance samples were analyzed regularly.

(8) Volatile Organic Compounds - Samples collected during the second sampling effort were analyzed for volatile organic compounds using gas chromatography/mass spectrometry. The apparatus and procedures used for analysis were in accordance with EPA Method 624. Samples collected during the third sampling effort were analyzed for ten select compounds using gas chromatography alone, with flame ionization and Hall detection systems. The ten compounds were selected on the basis of the earlier GC/MS measurements. Quality control procedures included thorough calibration and manual review of data generated by the instrument computer systems.

ESTIMATED DETECTION LIMITS
FOR ANALYTES DETERMINED IN
GROUNDWATER FROM MYRTLE BEACH AIR FORCE BASE

Analyte	Detection Limit
pH	$\pm$ 0.05 pH units
Conductivity	$\pm$ 5 micromho
TOC	0.5 ppm
TOX	50 ppb
Phenol	0.05 ppm
Sulfate	0.05 ppm
Nitrate	0.05 ppm
Chloride	0.01 ppm
Bicarbonate	0.25 ppm
Iron	0.2 ppb
Manganese	0.1 ppb
Sodium	0.2 ppb
Arsenic	2 ppb
Barium	2 ppb
Chromium	0.5 ppb
Lead	0.5 ppb
Mercury	0.01 ppb
Zinc	0.05 ppb
Selenium	5 ppb
Vanadium	2 ppb
Calcium	0.5 ppb

(continued)

ESTIMATED DETECTION LIMITS
FOR ANALYTES DETERMINED IN
GROUNDWATER FROM MYRTLE BEACH AIR FORCE BASE

Analyte	Detection Limit
Magnesium	0.02 ppb
Potassium	0.5 ppb
Benzene	0.5 ppb
Toluene	0.5 ppb
Ethylbenzene	0.5 ppb
Chloroform	0.05 ppb
Chloroethane	0.10 ppb
Methylene chloride	0.10 ppb
1,2-Dichloroethane	0.5 ppb
1,2-trans-DChloroethylene	0.5 ppb
Chlorobenzene	0.1 ppb
1,1-Dichloroethane	0.5 ppb

APPENDIX B

INFORMATION PERTAINING TO WATER WELLS LOCATED WITHIN AND ADJACENT TO MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Water Well Information

Source Reference	Zack Well References	SCWRC Well References	Well Owner	Latitude/ Longitude	Well Use	Total Depth (ft)	Screened Interval (ft)	Approximate Pumping Rate (x 1000 gpd)	Specific Location
1,2	HO-333	6T- i1	City of Myrtle Beach	33 38 34/ 78 56 40	P.S.	746	308-638	691	Pirate Land Campground on east side of US Hwy 17, 1400 ft. southwest of Academy Drive jct. with US Hwy 17
1	NA	6T-c1	Ocean Lakes Ltd. c/o Ocean Lakes Family Campground	33 39 05/ 78 57 16	P.S.	462	NA	288	West side of S.C. Hwy 394 at jct. of Moonlight Drive and Orion Drive in Crystal Lake Mobile Home Village
1	NA	6S-t2	Grand Strand Water & Sewer Authority, Conway, S.C.	33 41 37/ 78 57 29	P.S.	432	NA	73	Watergate Subdivision, 2.5 mi. east of jct. S.C. Hwy 707 and S.C. Hwy 544, then 0.7 mi. north of S.C. Hwy 707
1	NA	6S-t3	Grand Strand Water & Sewer Authority, Conway, S.C.	33 41 37/ 78 57 29	P.S.	421	NA	79	Watergate Subdivision, 2.5 mi. east of jct. S.C. Hwy 707 and S.C. Hwy 544, then 0.7 mi. north of S.C. Hwy 707, next to well 6S-t2
1	NA	6S-s1	Grand Strand Water & Sewer Authority, Conway, S.C.	33 41 43/ 78 56 32	P.S.	463	NA	288	100 ft. south of S.C. Hwy 707. 3.5 mi. east of jct. of S.C. Hwy 707 and Hwy 544
1,2	HO-279	6S-k1	Four Seasons Ice Co. Conway, S.C.	33 42 45/ 78 55 17	P.S.	416	NA	30	300 ft. southwest of jct. of S.C. Hwy 501 and Waterside Dr., Myrtle Beach
1	NA	5S-y1	City of Myrtle Beach	33 40 43/ 78 54 08	P.S.	630	NA	576	500 ft. northwest of intersection of US Hwy 17 and 13th Avenue South, Myrtle Beach
1,2	HO-396	5S-y2	Aerovox Ceramics Company, Myrtle Beach	33 40 31/ 78 54 29	P.S.	584	398-584	260	1800 ft. northwest of US Hwy 17 on Aerovox Road, Myrtle Beach
1	NA	5S-y3	City of Myrtle Beach	33 40 12/ 78 54 39	P.S.	674	NA	778	500 ft. southwest of jct. of 21st Avenue North and Cassandra Lane, Myrtle Beach

Water Well Information (Cont.)

Source Reference	Zack Well References	SCWRC Well References	Well Owner	Latitude/ Longitude	Well Use	Total Depth (ft)	Screened Interval (ft)	Approximate Pumping Rate (x 1000 gpd)	Specific Location
1,2	HO-69	5S-y4	City of Myrtle Beach	33 40 31/ 78 54 29	P.S.	575	NA	720	900 ft. northwest of jct. of US Hwy 17 and Aerovox Road, Myrtle Beach
1	HO-36	5S-y5	MBAFB (Bombing)	33 40 30/ 78 54 21	NA	572	506-560	NA	NA
1,2	HO-37	5S-y8	MBAFB (Bombing)	33 40 25/ 78 54 35	NA	214	108-214	NA	NA
1	NA	6T-a1	City of Myrtle Beach	33 39 40/ 78 55 07	P.S.	718	NA	748	900 ft. west of intersection of 29th Avenue South and Ocean Blvd., Myrtle Beach
2	HO-226	6T-b1	MBAFB No. 3	33 39 38/ 78 56 53	NA	760	512-756	NA	NA
2	HO-218	6T-b2	MBAFB No. 4	33 39 25/ 78 56 13	NA	787	553-787	NA	NA
1	NA	6T-b3	MBAFB No. 2	NA	NA	NA	NA	NA	NA
1	NA	6S-v1	MBAFB No. 1	NA	NA	NA	NA	NA	NA
2,3	HO-340	NA	Pine Island, Myrtle Beach	33 42 04/ 78 54 44	NA	804	403-707	NA	NA
3	HO-350	NA	MBAFB Motor Pool Area (Bldg. No. 514)	33 40 54/ 78 56 38	NA	42	32-42	NA	NA
4	NA	NA	MBAFB Low Fluoride Well (Bldg. No. 690)	33 39 25/ 78 56 18	P.S.	32	unknown	NA	Along Alder Street about 150 feet southwest of the lake, in Bldg. 690

NA - Not Available
P.S.- Public Supply

Sources:
1 - South Carolina Water Resources Commission (SCWRC)
2 - Zack, 1980, USGS Water Supply Paper 2067
3 - Zack, 1977, USGS/SCWRC Report No. 8
4 - EPA, 1977, Draft Environmental Impact Statement, Grand Strand Region, SC, pgs. 2-21.

GM-7
Fire Training Areas 1 & 2
(installed 11-10-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	6-8-13-10	4	Sand, fine, little silt, with lenses of higher silt-clay content, light brown, moist
3 - 5	9-7-8-7	240	Sand, fine, little silt, with lenses of clay and organics, brown, moist
5 - 7	1-1-1-2	180	Sand, fine, clay and silt, mottled orange brown and light grey, very moist; Encountered water at 7 ft
9 - 11	1-1-1-1	6	Clay, little silt, trace fine sand, light grey, very moist
13 - 15	5-8-6-7	6	Sand, fine, trace clay and silt, light grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 12.5 feet below land surface
Screened Interval: 2.5 to 12.5 feet

GM-6
Fire Training Areas 1 & 2
(installed 11-15-82)
(continued)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
24 - 26	$\frac{WOH}{12} - \frac{1}{12}$	56	Sand, fine, little clay and silt, with lenses of higher silt-clay content, grey, wet
30 - 31.5	1-2-3	60	Sand, fine, clay and silt, light grey with some iron staining, wet

Borehole Depth: 31.5 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 20 to 30 feet

GM-6
Fire Training Areas 1 & 2
(installed 11-15-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	9-13-20-12	0.2	Sand, fine, little silt, with lenses of higher silt-clay content, brown, moist
3 - 5	4-3-2-3	520	Clay, silt and fine sand, mottled orange brown and light grey, with silty, organic black zone at top of sample, very moist
5 - 7	2-3-3-4	340	Clay, silt and fine sand, mottled orange brown and light grey, very moist
9 - 11	3-1-1-1	2.0	Clay and silt, light grey with some orange brown mottling, very moist
14 - 16	1-5-12-14	12	Clay and silt, mottled orange brown and grey over sand, fine, trace clay and silt, dark grey, wet; Encountered water at 14 ft
19 - 21	1-1-1-1	42	Sand, fine, trace clay and silt, grey, wet, with dark grey clay and silt at end of sample

GM-5
Fire Training Areas 1 & 2
(installed 11-10-82)

Borehole Depth: 12.5 feet below land surface
Well Depth: 12.5 feet below land surface
Screened Interval: 2.5 to 12.5 feet

GM-6, a 30-foot well adjacent to GM-5, was sampled in lieu of sampling GM-5.

GM-4
Fire Training Areas 1 & 2
(installed 11-9-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	7-14-15-15	4.0	Sand, fine, little silt, dark brown, moist
3 - 5	10-16-19-14	40	Sand, fine, trace silt, light grey, moist
5 - 7	1-2-1-1	420	Sand, fine, some clay and silt, mottled orange brown and light grey, very moist; Encountered water at 6 ft
9 - 11	3-$\frac{1}{12}$-1	10	Clay and silt, little fine sand, dark grey, wet
13 - 15	1-1-$\frac{1}{12}$	100	Sand, fine, clay and silt, grey, wet

Borehole Depth: 15 feet below land surface
Well Dept.. 13.5 feet below land surface
Screened Interval: 3.5 to 13.5 feet

GM-3
Fire Training Areas 1 & 2
(installed 11-9-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	8-10-12-12	0.2	Sand, fine, some clay and silt, mottled orange brown and grey, moist
3 - 5	8-12-14-10	240	Sand, fine, some clay and silt, grey, with black organic zone at top of sample, moist
5 - 7	1-3-5-9	100	Sand, fine, some clay and silt, grey, very moist; Encountered water at 7 ft
9 - 11	2-2-6-18	18	Sand, fine, little clay and silt, with lenses of higher silt-clay content, light grey, wet
13 - 15	5-6-6-9	22	Sand, fine, trace clay, silt and lenses of higher silt-clay content, light grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 12.5 feet below land surface
Screened Interval: 2.5 to 12.5 feet

GM-2
Fire Training Areas 1 & 2
(installed 11-9-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	5-12-9-11	1.0	Sand, fine, little silt, trace roots and wood, brown, moist
3 - 5	9-15-14-11	40	Sand, fine, little silt, brown to light grey, moist
5 - 7	2-2-6-7	12	Sand, fine, little clay and silt, with occasional clay lens, light grey, very moist; Encountered water at 7 ft
9 - 11	6-14-19-30	0.8	Sand, fine, trace silt, light grey, wet
13 - 15	1-4-5-4	0.3	DO

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-1
Fire Training Areas 1 & 2
(installed 11-8-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	12-10-15-20	26	Sand, fine, little clay and silt, with lenses of higher silt-clay content, dark brown, moist, (fuel odor)
4 - 6	4-3-2-3	760	Sand, fine, clay and silt, mottled orange brown and light grey, moist, (fuel odor); Encountered water at 6 ft
6 - 8	3-4-7-5	1000	Sand, fine, some clay and silt, mottled orange brown and light grey, very moist, (fuel odor)
9 - 11	2-3-6-14	620	Sand, fine, little clay and silt, with some clay-rich zones, light grey, wet
13 - 15	5-4-3-3	3.2	Sand, fine, trace silt, light grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 12.5 feet below land surface
Screened Interval: 2.5 to 12.5 feet

B-5
Fire Training Areas 1 & 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	6-12-9-10	12	Sand, fine, little silt, with lenses of higher silt-clay content, dark brown, moist, (fuel odor)
4 - 6	9-5-3-5	210	Sand, fine, some clay and silt, mottled orange brown and light grey, very moist, (fuel odor)
6 - 8	4-7-7-4	260	Sand, fine, little clay and silt, mottled orange brown and light grey, (fuel odor); Encountered water at 6 ft
8 - 10	3-5-9-17	4.8	Sand, fine, some clay and silt, mottled orange brown and light grey, very moist

Borehole Depth: 10 feet below land surface

B-4
Fire Training Areas 1 & 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	9-5-9-12	44	Sand, fine, little silt, with lenses of higher silt-clay content, dark brown, moist, (fuel odor)
4 - 6	2-1-2-3	600	Sand, fine, some clay and silt, mottled orange brown and light grey, moist, (fuel odor); Encountered water at 6 ft
6 - 8	3-5-3-3	240	Sand, fine, some clay and silt, mottled orange brown and light grey, wet, (fuel odor)
8 - 10	3-5-6-11	4.4	Sand, fine, trace silt, light grey, wet, (fuel odor)

Borehole Depth: 10 feet below land surface

B-3
Fire Training Areas 1 & 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	12-12-15-18	140	Sand, fine, little silt, roots, wood, dark brown, moist, (fuel odor)
4 - 6	2-2-2-2	400	Sand, fine, clay and silt, mottled orange brown and light grey, very moist, (fuel odor); Encountered water at 6 ft
6 - 8	2-3-5-4	--	No recovery
8 - 10	2-2-3-5	4.6	Clay, some fine sand and silt, mottled orange brown and grey, moist

Borehole Depth: 10 feet below land surface

B-2
Fire Training Areas 1 & 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	5-7-9-5	14	Sand, fine, little silt, with lenses of higher silt-clay content, dark brown, moist
3 - 5	2-3-4-3	460	Sand, fine, some silt, with roots, dark brown, moist
5 - 7	2-4-4-3	590	Sand, fine, clay and silt, mottled orange brown and light grey, very moist; Encountered water at 8 ft
8 - 10	1-2-2-3	10	Sand, fine, clay and silt, mottled orange brown and light grey, wet

Borehole Depth: 10 feet below land surface

B-1
Fire Training Areas 1 & 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 2	7-8-11-12	9.0	Sand, fine, little silt, with lenses of higher silt-clay content, very dark brown to black, moist, (fuel odor)
2 - 4	11-12-14-18	120	Sand, fine, little silt, light brown, moist, (fuel odor)
4 - 6	10-11-8-10	84	Sand, fine, little clay and silt, brown, moist, (fuel odor); Encountered Water at 6 ft
6 - 8	6-4-7-10	>1000	Sand, fine, trace silt, light brown, moist, (fuel odor)
8 - 10	6-2-1-1	300	Sand, fine, trace silt, light brown, wet, (slight fuel odor)

Borehole Depth: 10 feet below land surface

APPENDIX C

LITHOLOGIC DESCRIPTIONS AND OVA ANALYSES OF MATERIALS ENCOUNTERED DURING THE DRILLING AND SOIL-SAMPLING PROGRAM CONDUCTED AT MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

GLOSSARY

Blow Count	Number of blows required to drive a 2" diameter split spoon 18" into soil (in 6" increments) using a 140 lb. hammer which is dropped 30."
DO	Ditto.
PUSH	Pushed with hydraulic head (in this case, pushed two feet.
WOH	Weight of hammer.
WOR	Weight of rods.

GM-8
Fire Training Areas 1 & 2
(installed 11-10-82)

Borehole Depth: 13 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-9, a 30-foot well adjacent to GM-8, was sampled in lieu of sampling GM-8.

GM-9
Fire Training Areas 1 & 2
(installed 11-15-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	12-20-23-23	2.8	Sand, fine, little silt, trace organics, brown, moist
3 - 5	5-3-4-5	750	Sand, fine, some clay and silt, trace organics, light brown, moist
5 - 7	2-3-3-3	290	DO
9 - 11	1-2-2-3	2.0	Clay and silt, trace fine sand, mottled orange brown and light grey, moist
14 - 16	4-5-12-9	0.8	Sand, fine, trace silt, grey, wet; Encountered water at 14 ft
19 - 21	$\frac{WOH}{12} - \frac{1}{12}$	36	Clay and silt, some shells, grey, very moist
24 - 26	$\frac{WOH}{12} - \frac{1}{12}$	48	Clay, silt and fine sand, some shells, grey, wet
29 - 31	2-2-2-2	20	DO

Borehole Depth: 31 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 20 to 30 feet

B-6
Landfill 3 - Weathering Pit 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
2 - 4	2-4-11-5	900	Sand, fine, some silt and organics, with concrete and wood in first foot of sample, dark brown, moist, (detergent odor, fill)
4 - 6	3-6-8-8	640	Clay and silt, some fine sand, mottled orange brown and light grey, moist
6 - 8	5-9-9-10	380	Clay and silt, some fine sand, mottled orange brown and light grey, over fine sand, little clay and silt, grey, very moist; Encountered water at 7 ft
8 - 10	11-15-18-19	580	Sand, fine, little clay and silt, with lenses higher in silt and clay content, light grey, wet

Borehole Depth: 10 feet below land surface

B-7
Landfill 3 - Weathering Pit 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	3-4-5-7	1000	Clay and silt, some fine sand; to fine sand, little clay and silt, grey, black and brown, moist, (fill)
3 - 5	4-6-8-10	>1000	Clay and silt, little fine sand and organics, brown, moist
5 - 7	2-5-5-6	>1000	Clay and silt, little fine sand, mottled orange brown and light grey, moist
8 - 10	8-15-20-15	>1000	Sand, fine, trace silt, grey, wet; Encountered water at 8 ft

Borehole Depth: 10 feet below land surface

B-8
Landfill 3 - Weathering Pit 2

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	19-12-10-7	5.0	Silt and fine sand, asphalt, brown, moist, (fill)
3 - 5	6-10-8-12	46	Clay and silt, trace fine sand, mottled orange brown and light grey, moist
5 - 7	2-3-5-6	8	Clay and silt, some fine sand, mottled orange brown and light grey, moist
8 - 10	17-19-21-16	54	Sand, fine, trace clay and silt, light grey, wet; Encountered water at 8 ft

Borehole Depth: 10 feet below land surface

GM-10
Landfill 3 - Weathering Pit 2
(installed 11-11-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-2-2-4	150	Clay and silt, some fine sand, mottled orange brown and light grey, moist
3 - 5	3-3-3-4	8.0	DO
5 - 7	1-2-3-3	2.0	Clay and silt, some fine sand, mottled orange brown and light grey over fine sand, little clay and silt, light grey, very moist; Encountered water at 6 ft
9 - 11	4-10-4-1	32	Sand, fine, trace silt, grey, wet
14 - 16	WOH/24	110	Clay and silt, some shells, grey, very moist

Borehole Depth: 16 feet below land surface
Well Depth: 14 feet below land surface
Screened Interval: 4 to 14 feet

GM-11
Landfill 3 - Weathering Pit 2
(installed 11-12-82)

Borehole Depth: 13 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-12, a 30-foot well adjacent to GM-11, was sampled in lieu of sampling GM-11.

GM-12
Landfill 3 - Weathering Pit 2
(installed 11-16-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	1-1-2-2	0.2	Clay and silt, trace fine sand and organics, mottled orange brown and light grey, moist
3 - 5	2-5-8-10	1.0	Clay and silt, little fine sand, mottled orange brown and light grey, moist
5 - 7	3-5-6-11	0.6	DO
9 - 11	6-11-12-14	1.6	Sand, fine, little clay and silt, grey, wet; Encountered water at 9 ft
14 - 16	$1-\frac{WOH}{12}-1$	92	Clay and silt, trace shells, grey, very moist
19 - 21	1-1-2-2	76	Clay and silt, trace shells, grey, over fine sand and shells little clay and silt, grey, wet
24 - 26	$\frac{WOR}{24}$	19	Sand, fine, trace silt, grey, wet
29 - 31	5-6-9-10	5	DO

Borehole Depth: 31 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 20 to 30 feet

GM-13
Landfill 3 - Weathering Pit 2
(installed 11-12-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	3-4-5-5	0	Clay and silt, little fine sand, mottled, light brown and orange brown, moist
3 - 5	3-5-5-6	0.2	Clay and silt, little fine sand, mottled orange brown and light grey, moist
5 - 7	3-5-5-7	0.2	DO; Encountered water at 7 ft
9 - 11	2-3-5-5	0	Sand, fine, little clay and silt, light grey, wet
13 - 15	5-4-3-1	110	Sand, fine, trace silt, grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-14
Landfill 3 - Weathering Pit 2
(installed 11-12-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-3-5-6	0	Clay and silt, some fine sand, mottled orange brown and grey, moist
3 - 5	7-8-8-13	0.2	Sand, fine, little clay and silt, grey, very moist; Encountered water at 5 ft
5 - 7	4-8-7-6	34	DO
9 - 11	$1-\frac{1}{12}-1$	30	Clay and silt, some shells, dark grey, very moist
13 - 15	$\frac{\text{WOH}}{24}$	18	DO

Borehole Depth: 15 feet below land surface
Well Depth: 11.5 feet below land surface
Screened Interval: 1.5 to 11.5 feet

GM-15
Landfill 3 - Weathering Pit 2
(installed 11-17-82)

Borehole Depth: 13 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-16, a 30-foot well adjacent to GM-15, was sampled in lieu of sampling GM-16.

GM-16
Landfill 3 - Weathering Pit 2
(installed 11-17-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	3-3-5-5	0.2	Clay and silt, some fine sand, mottled light grey and orange brown, moist
3 - 5	6-8-8-9	0	Clay and silt, little fine sand, mottled light grey and orange brown, moist
5 - 7	3-4-5-3	0.9	Sand, fine, some clay and silt over fine sand, little clay and silt, grey, wet; Encountered water at 6 ft
9 - 11	$\frac{WOH}{6}$ - $\frac{1}{12}$ -1	6.6	Clay, some silt and shells, dark grey, very moist
14 - 16	1- $\frac{1}{12}$ -1	5.0	Sand, fine, some clay and silt, dark grey, wet
19 - 21	3-2-4-4	0.8	Clay, little silt, trace fine sand, greenish-grey, very moist
24 - 26	1-3-3-3	0.7	Clay, little silt and sand, greenish-grey with orange brown sand stringers, very moist
29 - 31	$\frac{WOH}{24}$	1.7	Sand, fine, trace silt, grey, wet

Borehole Depth: 31 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 20 to 30 feet

GM-17
Landfill 3 - Weathering Pit 2
(installed 11-16-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 3	-	0.2	Clay and silt, mottled light grey and orange brown, moist
3 - 4	-	90	Sand, fine, some clay, grey, wet; Encountered water at 3 ft
4 - 5.4	-	910	Sand, fine, trace clay and silt, wet

Borehole Depth: 5.4 feet below land surface
Well Depth: 5.4 feet below land surface
Screened Interval: 0.4 to 5.4 feet

GM-18
Landfill 3 - Weathering Pit 2
(installed 12-4-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 1.5	-	0	Clay and fine sand, mottled grey and orange brown, moist
1.5 - 5.4	-	0.8	Sand, fine, trace fines, grey, wet; Encountered water at 1.5 ft

Borehole Depth: 5.4 feet below land surface
Well Depth: 5.4 feet below land surface
Screened Interval: 0.4 to 5.4 feet

GM-24
Weathering Pit 1
(installed 11-19-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 2	7-11-14-16	0.1	Sand, fine and silt, some organics, dark brown, over clay, silt and fine sand, mottled light grey and orange brown, moist
2 - 4	4-5-7-8	0	Clay, silt and fine sand, mottled light grey and orange brown, moist
4 - 6	5-5-17-3	0	Clay, silt and fine sand, mottled light grey and orange brown over fine sand, trace clay and silt, light grey, moist; Encountered water at 6 ft
8 - 10	7-9-13-15	0.3	Sand, fine, little clay and silt, grey, wet, (fuel odor)
13 - 15	1-5-1-1	36	DO

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-23
Weathering Pit 1
(installed 11-19-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 2	6-8-6-6	0.2	Sand, fine and silt, some organics, dark brown, grading down to clay, silt and fine sand, mottled light grey and orange brown, moist
2 - 4	2-3-5-4	0	Clay and silt, little fine sand, mottled grey and orange brown, moist
4 - 6	4-3-3-4	0	Sand, fine, some clay and silt, mottled light grey and orange brown, moist
8 - 10	$\frac{WOR}{12}$ -8-12	0.4	Sand, fine, trace clay and silt, dark grey, wet, (slight fuel odor); Encountered water at 8 ft
13 - 15	1-1- $\frac{1}{12}$	34	DO

Borehole Depth: 13 feet below land surface
Well Depth: 15 feet below land surface
Screened Interval: 3 to 13 feet

B-15
Weathering Pit 1

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	3- $\frac{1}{18}$	0.5	Clay, silt and fine sand, mottled light grey and orange brown, moist
3 - 5	1-2-6-12	0	Sand, fine, trace clay and silt, orange brown, moist
5 - 7	4-8-13-28	0	DO
8 - 10	2-6-10-15	0.2	Sand, fine, little clay and silt, dark grey, wet; Encountered water at 8 ft

Borehole Depth: 10 feet below land surface

B-14
Weathering Pit 1

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 2	2-3-3-5	0.2	Sand, fine, some clay and silt, grey, moist, (fuel odor)
2 - 4	2-2-3-4	7.6	Sand, fine, clay and silt, mottled light grey and orange brown, moist, (fuel odor)
4 - 5	60/12	6.9	Sand, fine, trace clay and silt, grey, moist, (fuel odor)
8 - 10	8-9-9-11	1.0	Sand, fine, trace silt, dark grey, wet; Encountered water at 8 ft

Borehole Depth: 10 feet below land surface

B-13
Weathering Pit 1

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	5-4-2-2	0.5	Clay and silt, trace fine sand, mottled light grey and orange brown, moist, (slight fuel odor)
3 - 5	2-3-3-4	2.8	Sand, fine, some clay and silt, light grey, very moist, (fuel odor)
9 - 11	1-2-5-7	0.5	Sand, fine, trace silt, wet, (slight fuel odor); Encountered water at 9 ft

Borehole Depth: 11 feet below land surface

B-12
Weathering Pit 1

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-2-3-3	0	Clay and silt, some fine sand, mottled light grey and orange brown, moist
3 - 5	2-2-4-6	0	Clay, silt and fine sand, mottled light grey and orange brown, moist
5 - 7	5-9-11-13	0	Sand, fine, some clay and silt over sand, fine, little clay and silt, orange brown to grey, wet; Encountered water at 5 ft
7 - 9	8-15-21-37	0.5	Sand, fine, little clay and silt, grey, wet
9 - 11	5-6-9-11	3.4	Sand, fine, trace silt, dark grey, wet

Borehole Depth: 11 feet below land surface

B-11
Weathering Pit 1

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-3-6-5	0.4	Sand, fine, silt, and clay, little organics, dark brown, moist
3 - 5	4-2-3-4	1.7	Clay and silt, some fine sand, mottled light grey and orange brown, moist, (slight fuel odor)
5 - 7	2-3-6-7	0.2	Sand, fine, some clay and silt, light grey, moist, (slight fuel odor)
7 - 9	5-8-6-5	0.3	DO
9 - 11	3-6-11-12	3.0	Sand, fine, little silt, light grey, wet, (slight fuel odor); Encountered water at 9 ft

Borehole Depth: 11 feet below land surface

GM-22
Fire Training Area 3
(installed 11-18-82)
(continued)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
29 - 31	WOR/24	46	Sand, fine, trace silt, dark grey, wet

Borehole Depth: 31 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 20 to 30 feet

GM-22
Fire Training Area 3
(installed 11-18-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	1-2-2-3	0.2	Clay and silt, little fine sand, mottled light grey and orange brown, moist
3 - 5	4-5-5-6	0.2	Clay and silt, some fine sand, mottled light grey and orange brown, moist
5 - 7	8-10-12-12	0.2	Clay, silt and fine sand, light grey, moist
9 - 11	4-7-7-11	2.0	Clay, silt and fine sand, mottled light grey and orange brown over fine sand, trace clay and silt, grey, wet; Encountered water at 9 ft
14 - 16	1-2-2-2	89	Clay, some silt and shells, with fine sand stringers, grey, wet
19 - 21	1-1-1-2	42	Sand, fine, trace silt and clay, with lenses of clay, some silt and shells, grey, wet
24 - 26	1-2-1-1	22	DO

GM-21
Fire Training Area 3
(installed 11-22-82)

Boring Depth: 13 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-22, a 30-foot well adjacent to GM-21, was sampled in lieu of sampling GM-21.

GM-20
Fire Training Area 3
(installed 11-17-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-2-3-5	98	Clay, silt and fine sand, some organics, mottled light grey and orange brown, with dark brown, moist
3 - 5	3-4-5-4	90	Clay and silt, trace fine sand, mottled light grey and orange brown, moist, (fuel odor)
5 - 7	6-8-10-10	60	Clay, silt and fine sand, mottled light grey and orange brown, very moist, (fuel odor)
9 - 11	1-2-2-3	200	Sand, fine, trace clay and silt, grey, wet, (slight fuel odor); Encountered water at 9 ft
13 - 15	1-1-2-2	120	Clay, some silt and shells, dark grey, very moist

Borehole Depth: 15 feet below land surface
Well Depth: 14 feet below land surface
Screened Interval: 4 to 14 feet

GM-19
Fire Training Area 3
(installed 11-17-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	5-5-8-8	0.2	Sand, fine and silt, some organics, dark brown, moist
3 - 5	4-5-8-8	0.3	Clay and silt, trace fine sand, mottled light grey and orange brown, moist
5 - 7	3-6-8-10	0.2	Clay and silt, some fine sand, mottled light grey and orange brown, moist
9 - 11	5-6-5-7	510	Sand, fine, trace silt, dark grey, wet, (fuel odor); <u>Encountered water at 9 ft</u>
13 - 15	1- $\frac{1}{12}$ -1	18	Clay, some silt, trace shells, dark grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

B-10
Fire Training Area 3

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-3-3-3	0.3	Clay and silt, trace fine sand, mottled light grey and orange brown, moist
3 - 5	3-3-4-5	0.6	DO
5 - 7	5-5-11-13	0.4	Sand, fine, trace clay and silt, light grey, wet; Encountered water at 6 ft
9 - 11	5-5-7-10	1.0	DO

Borehole Depth: 11 feet below land surface

B-9
Fire Training Area 3

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-2-2-3	0.3	Clay and silt, some fine sand near top of sample, mottled light grey and orange brown, black near top, moist
3 - 5	3-5-8-11	0.2	Clay and silt, mottled light grey and orange brown, moist, (fuel odor)
5 - 7	6-10-11-12	1.0	Sand, fine, trace silt, light grey, wet; Encountered water at 5 ft
9 - 11	2-3-3-6	90	Sand, fine, clay and silt, grey with some orange brown, very moist

Borehole Depth: 11 feet below land surface

GM-25
Weathering Pit 1
(installed 11-19-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 2	4-6-11-12	5.2	Sand, fine, clay and silt, mottled light grey and orange brown, moist
2 - 4	3-5-5-9	0.4	Clay and silt, some fine sand, mottled light grey and orange brown, moist
6 - 8	10-13-15-18	0	Sand, fine, trace silt, light grey, wet; Encountered water at 7 ft
8 - 10	5-8-10-13	0.5	DO
13 - 15	$\frac{1}{12}$ - $\frac{1}{12}$	3.8	Sand, fine, clay and silt, over clay, silt, little fine sand, trace shells, dark grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-26
Weathering Pit 1
(installed 11-22-82)

Borehole Depth: 13 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-27, a 30-foot well adjacent to GM-26, was sampled in lieu of sampling GM-26

GM-27
Weathering Pit 1
(installed 11-23-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
0 - 2	2-2-3-3	1.5	Silt and fine sand, some organics, dark brown, moist, over clay and silt, some fine sand, mottled gray and orange brown, moist (fuel odor)
2 - 4	3-3-5-8	19	DO
4 - 6	6-11-17-29	22	Sand, fine, trace silt, light grey to white, wet, (fuel odor); Encountered water at 5 ft
8 - 10	1-1-1-1	1.4	DO
14 - 16	WOH/24	40	Sand, fine, some clay and silt, over clay, some silt, dark grey, wet to very moist
19 - 21	WOH/24	99	Clay, some silt and shells, very moist
24 - 26	WOH/24	>1000	DO
29 - 31	WOH/24	>1000	DO
34 - 36	WOR/24	67	Sand, fine, some medium sand, trace silt, grey, wet

Borehole Depth: 36 feet below land surface
Well Depth: 35 feet below land surface
Screened Interval: 25 to 35 feet

B-16
Landfill 4

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-3-3-4	0.2	Sand, fine and debris (wood, rubber, metal, paper, etc.), little silt, brown, moist
3 - 5	4-5-5-6	>1000	DO
5 - 7	6-7-9-9	2	DO
8 - 10	3-7-11-12	42	DO (wet); Encountered water at 8 ft

Borehole Depth: 10 feet below land surface

B-17
Landfill 4

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	4-8-11-31	>1000	Sand, fine and debris, some silt, brown, moist
3 - 5	3-1- 35/1"	>1000	DO
5 - 7	50/12"	70	DO
8 - 10	6-10-14	8	DO (wet); Encountered water at 7 ft

Borehole Depth: 10 feet below land surface

B-18
Landfill 4

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	6-11-14-26	>1000	Sand, fine and debris, some silt, dark brown, moist
3 - 5	9-14-17-41	220	DO
5 - 7	15-19-30-36	120	DO
8 - 10	11-19-24-28	160	DO (wet); Encountered water at 7 ft

Borehole Depth: 10 feet below land surface

B-19
Landfill 4

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	3-4-4-6	80	Sand, fine, some debris, little silt
3 - 5	5-5-5-9	65	DO
5 - 7	9-14-21-33	20	DO (wet; Encountered water at 5 ft
8 - 10	5-14-26-37	7.0	DO

Borehole Depth: 10 feet below land surface

B-20
Landfill 4

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	3-29- $\frac{42}{2"}$	0.3	Sand fine, little silt, brown, wet; Encountered water at surface
3 - 5	14-3-3-11	2.6	DO
5 - 7	12-18-27- $\frac{10}{1"}$	0.4	DO
8 - 10	11-43- $\frac{20}{1"}$	0.6	DO

Borehole Depth: 10 feet below land surface

GM-28
Landfill 4
(installed 11-30-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-3-3-3	0	Sand, fine, some silt and organics, dark brown, moist; Encountered water at 3 ft
3 - 5	3-4-4-5	0.2	DO
5 - 7	5-7-7-9	0.6	DO
9 - 11	2-3-3-2	0.8	Sand, fine, little silt, trace organics, brown, wet
14 - 16	$\frac{1}{12}$ - $\frac{1}{12}$	20	Clay and silt, grey, very moist
19 - 21	5-4-4-6	0.3	Sand, medium to fine, little silt and clay, grey, wet
24 - 26	1-1-1-1	0.4	Sand, medium to fine, little silt and shells, grey, wet
29 - 31	$\frac{1}{12}$ -1-2	3.6	Sand, medium to fine and shells, some silt, grey, wet

Borehole Depth: 31 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 20 to 30 feet

GM-29
Landfill 4
(installed 11-30-82)

Borehole Depth: 12.5 feet below land surface
Well Depth: 12.5 feet below land surface
Screened Interval: 2.5 to 12.5 feet

GM-28, a 30-foot well adjacent to GM-29, was sampled in lieu of sampling GM-29.

GM-30
Landfill 1
(installed 12-1-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	4-7-10-12	0	Sand, fine, some silt and organics, dark brown, moist
3 - 5	18- $\frac{31}{6}$	0	DO
9 - 11	7-10-3-5	0	Sand, fine, little silt, light brown, wet; Encountered water at 8 ft
14 - 16	2-3-6-17	0.2	Sand, fine, little silt, greenish grey, wet
19 - 21	6-4-1-1	0.6	Sand, fine, little silt, light brown to grey, wet
24 - 26	2-3-29- $\frac{50}{2}$	0	DO
29 - 31	4-2-3-1	3.4	Clay and silt, little fine sand and shells, grey, very moist

Borehole Depth: 31 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 20 to 30 feet

GM-31
Landfill 1
(installed 11-30-82)

Borehole Depth: 13 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-30, a 30-foot well adjacent to GM-31, was sampled in lieu of sampling GM-31.

GM-32
Landfills 1 & 4
(installed 12-1-81)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	7-9-9-11	0.2	Sand, fine, trace silt and organics, brown, moist
3 - 5	8-14-39-21	1.0	Sand, fine, some silt and organics, dark brown, moist
5 - 7	14-18-24-27	0.1	Sand, fine, little silt and organics, brown, wet; Encountered water at 5 ft
9 - 11	1-2-2-2	0.6	DO
13 - 15	1-1-2-3	1.8	Sand, fine, trace silt, greenish grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

B-21
POL Area

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	5-4-4-4	0	Clay and silt, some fine sand, mottled light grey and orange brown, moist
3 - 5	2-3-5-8	0	Sand, fine, trace silt, light grey, moist
5 - 7	12-20-17-15	1.3	DO; Encountered water at 6 ft

Borehole Depth: 7 feet below land surface

GM-46
Landfill 4
(installed 6-3-83)

Borehole Depth: 15 feet below land surface
Well Depth: 15 feet below land surface
Screened Interval: 5 to 10 feet

GM-45, a 30-foot well adjacent to GM-46, was sampled in lieu of sampling GM-46.

GM-45
Landfill 4
(installed 6-3-83)

Sampling Interval Depth (ft)	Blow Count	Description
0 - 1.5	4-6-7	Sand, fine, little silt, roots and organics, brown, dry
5 - 6.5	16-20-25	Sand fine, little silt and organics, dark brown, moist
10 - 11.5	3-4-5	DO
15 - 16.5	3-4-5	Sand, fine to medium, trace silt, light brown to grey, wet, encountered water at 15 feet
20 - 21.5	4-6-5	DO
25 - 26.5	7-14-10	Sand, fine to medium, little shells, trace silt, light grey, wet
30 - 31	-	Sand, fine to medium, trace shells and silt, grey to brown, wet

Borehole Depth: 31 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 25 to 30 feet

GM-44
POL Area
(installed 6-3-83)

Sampling Interval Depth (ft)	Blow Count	Description
1 - 15	-	Not sampled, see GM-35 for lithology
15 - 17	Push 24"	Shelby tube, 24" recovery, clay and silt, trace shells grey, very moist
20 - 21.5	WOR-1-1	DO
25 - 26.5	WOR-2-4	DO
30 - 31.5	WOR-3-8	Clay and silt, trace shells grey, very moist grading down to sand, fine to medium, some silt, trace clay light grey, wet
35 - 36.5	4-4-4	Sand, fine to medium, light grey, wet

Borehole Depth: 36.5 feet below land surface
Well Depth: 35 feet below land surface
Screened interval: 30 to 35 feet

GM-43
Weathering Pit 1
(installed 6-2-83)

Sampling Interval Depth (ft)	Blow Count	Description
1 - 15	-	Not sampled, see GM-24 for lithology
20 - 22	Push 24"	Shelby tube, 24" recovery clay and silt, trace shells grey, very moist
25 - 27	WOH/12-2-2	DO
30 - 32	WOH/24	DO
35 - 37	4-2-3-2	Sand, fine, trace silt and clay, light grey, wet

Borehole Depth: 37 feet below land surface
Well Depth: 35 feet below land surface
Screened Interval: 30 to 35 feet

GM-42
Fire Training Area 3
(installed 6-2-83)

Sampling Interval Depth (ft)	Blow Count	Description
1 - 15	-	Not sampled, see GM-19 for lithology
15 - 17	Push 24"	Shelby tube, 24" recovery, clay and silt, trace shells grey, very moist
20 - 22	1-6-9-1	Sand, fine, some silt and clay, grey, wet
25 - 27	1-3-5-5	Sand, fine, little silt and clay, grey with clay and silt rich zones, wet
30 - 32	2-3-4-3	Sand, fine to medium, little silt and clay, grey

Borehole Depth: 32 feet below land surface
Well Depth: 30 feet below land surface
Screened Interval: 25 to 30 feet

GM-41
Landfill 3 - Weathering Pit 2
(installed 6-2-83)

Sampling Interval Depth (ft)	Blow Count	Description
1 - 10	-	Not sampled, see GM-14 for lithology
10 - 12	Push 24"	Shelby tube - no recovery
12.5 - 14.5	Push 24"	Shelby tube, 24" recovery, clay and silt, trace shells grey, very moist
20 - 21.5	WOH/12-6	DO
25 - 26.5	WOH/18	DO
30 - 31.5	WOH/18	Sand, fine to medium, little silt and clay, occasional clay lenses, grey, west

Borehole Depth: 33 feet below land surface
Well Depth: 33 feet below land surface
Screened Interval: 28 to 33 feet

GM-40
Flight Line
(installed 12-3-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-3-2-1	0	Sand, fine and silt, trace organics, brown, moist
5 - 7	5-2-2-2	0	Clay, silt and fine sand, mottled light grey and orange brown, moist
8 - 10	3-$\frac{1}{12}$-1	0.2	Clay, some silt, little fine sand, dark grey, very moist
15 - 17	8-9-10-8	0	Sand, fine, little silt, dark grey, wet; Encountered water at 12 ft

Borehole Depth: 17 feet below land surface
Well Depth: 15 feet below land surface
Screened Interval: 5 to 15 feet

GM-39
Flight Line
(installed 12-3-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	7-9-10-8	0	Sand, fine, trace silt and organics, brown, moist
5 - 7	1-2-2-2	0.3	Sand, fine and peat, some silt, dark brown, moist
8 - 10	9-15-13-9	0.2	Sand, fine, trace silt, light grey, wet; Encountered water at 8 ft
15 - 17	7-6-5-5	0.1	Sand, fine, trace silt, brown, wet

Borehole Depth: 17 feet below land surface
Well Depth: 15 feet below land surface
Screened Interval: 5 to 15 feet

GM-38
Flight Line
(installed 12-3-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	5-8-12-15	0	Sand, fine, some silt and organics, dark brown, moist
5 - 7	3-2-5-6	0.6	Silt and peat, little fine sand, dark brown, moist
8 - 10	3-2-5-8	2.6	Sand, fine, little silt and organics, brown, moist
15 - 17	9-8-9-10	0.4	Sand, fine, trace silt, light grey, very moist

Borehole Depth: 17 feet below land surface
Well Depth: 15 feet below land surface
Screened Interval: 5 to 15 feet

GM-37
Flight Line
(installed 12-3-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	3-4-5-6	0.1	Sand, fine, some silt and organics, dark brown, moist
3 - 5	5-9-9-11	0	Sand, fine, little silt, brown, moist
9 - 11	21-11-9-8	0.2	Sand, fine, trace silt, light grey, with dark brown organic zone in tip, wet; Encountered water at 9 ft
13 - 15	5-5-9-7	0.8	Sand, fine, trace silt, light grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 14 feet below land surface
Screened Interval: 4 to 14 feet

GM-36
POL Area
(installed 12-2-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	2-3-2-4	0	Sand, fine, silt and clay, mottled light grey and orange brown, moist
3 - 5	3-6-6-9	0.1	Sand, fine, little silt, grey, moist, (slight fuel odor)
9 - 11	10-16-17-11	0	DO (wet); Encountered water at 6 ft
13 - 15	$\frac{1}{12}-\frac{1}{12}$	0.7	Clay, some silt, grey, very moist

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-35
POL Area
(installed 12-2-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	4-5-4-4	0	Sand, fine, some silt, trace organics, brown, moist
3 - 5	3-3-5-5	9.4	Clay, silt and fine sand, mottled light grey and orange brown, very moist, (fuel odor)
9 - 11	4-5-7-7	1.1	Sand, fine, trace silt, grey, wet; Encountered water at 6 ft
13 - 15	WOR/24	0.1	Clay, some silt and fine sand lenses and shells, grey, very moist

Borehole Depth: 15 feet below land surface
Well Depth: 13 feet below land surface
Screened Interval: 3 to 13 feet

GM-34
POL Area
(installed 12-2-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	1-3-3-3	0	Sand, fine and silt, some organics, dark brown over clay, silt and fine sand, mottled light grey and orange brown, moist
3 - 5	2-2-2-2	0	Clay and silt, some fine sand, mottled light grey and orange brown, moist
9 - 11	4-5-8-10	0.2	Sand, fine, trace silt and clay, light brown, wet; Encountered water at 7 ft
14 - 16	WOR/24	0.4	Clay and fine sand, some silt, grey, wet

Borehole Depth: 16 feet below land surface
Well Depth: 14 feet below land surface
Screened Interval: 4 to 14 feet

GM-33
POL Area
(installed 12-2-82)

Sampling Interval Depth (ft)	Blow Count	OVA Value (ppm)	Description
1 - 3	1-3-2-1	0	Sand, fine, and silt, some organics, dark brown, moist
3 - 5	2-2-5-6	0	Clay, silt and fine sand, mottled light grey and orange brown, moist
9 - 11	7-9-14-9	0	Sand, fine, trace silt, grey, wet; Encountered water at 8 ft
13 - 15	WOR/24	1.1	Clay, some silt, little fine sand, grey, wet

Borehole Depth: 15 feet below land surface
Well Depth: 14.5 feet below land surface
Screened Interval: 4.5 to 14.5 feet

APPENDIX D

PROCEDURES AND FINDINGS OF SURFACE GEOPHYSICAL SURVEYS CONDUCTED AT MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Part D-1: Preliminary Geophysical Surveys Conducted at the Flight Line, POL, and Pipline Spill Areas

Part D-2: Final Geophysical Survey Conducted in the Pipeline Spill Area

Part D-1: Preliminary Geophysical Surveys Conducted at the Flight Line, POL, and Pipline Spill Areas

EarthTech Research Corporation

November 10, 1982

Geraghty and Miller, Inc.
844 West Street
Annapolis, MD 21401

Attention: Mr. Jeff Sgambat

Re: Geophysical surveys to determine the extent of fuel spills and the optimum location for monitoring wells at the Myrtle Beach AFB

Dear Jeff:

EarthTech wishes to take this opportunity to express interest in carrying out geophysical surveys at the Myrtle Beach AFB in cooperation with Geraghty and Miller, Inc., to help map the extent of fuel spills in the ground and also to help Geraghty and Miller, Inc., decide upon the optimum location and number of ground water monitoring wells.

The Problem

We understand there have been a number of fuel spills over the past 20 years on the Myrtle Beach Air Force Base, and that the Air Force wishes to cleanup any fuel still remaining in the ground. Geraghty and Miller, Inc., are responsible for determining if any spilled fuel still exists in the ground and if it does they must determine the quantity and extent of the fuel in the ground. Geophysical surveys can help to rapidly map the extent of the fuel in the ground. Further, the geophysical surveys can assist in determining the optimum locations for the ground water monitoring wells.

Summary of Geophysical Surveys

Preliminary geophysical surveys, using a non-contacting terrain conductivity meter, were carried out at three Myrtle Beach locations on the 27th of October, 1982, by Les Davis of EarthTech Research Corporation. No significant anomalies in the electrical conductivity of the unsaturated or the saturated soil were found at the POL site where 10,000 gallons of fuel were spilled 18 years ago or on the runway side of Building 357, where fuel was apparently detected in a well adjacent to the building five years ago by the Municipality of Myrtle Beach.

A very significant conductivity anomaly was observed near the Myrtle Beach Pipeline Corporation Tank Farm where over 120,000 gallons of fuel were spilled earlier this year. It is interesting to note that the electrical conductivity anomaly around the MBPC tank farm extends further west than was earlier expected along the old railroad bed to a stream. It may be that the ground water flow from the spill area extends both to the east as expected, and to the west as was not expected.

6655 Amberton Drive, Baltimore, Maryland 21227 / (301) 796-5200

Geophysical surveys using the ground conductivity meter offers a rapid means of measuring the extent of the electrical conductivity anomaly associated with the spilled fuel in the area of the MBPC tank farm. The geophysical surveys will help Geraghty and Miller economically place the ground water monitoring wells in optimum locations to determine the extent and concentration of the leaked fuel around the tank farm.

In the following section we present and discuss the results of the preliminary electrical conductivity measurements carried out at the Myrtle Beach AFB. Next we shall offer a few recommendations based on the surveys carried out, and finally, outline the costs already incurred and the cost of future recommended geophysical surveys.

Results of the Preliminary Geophysical Surveys

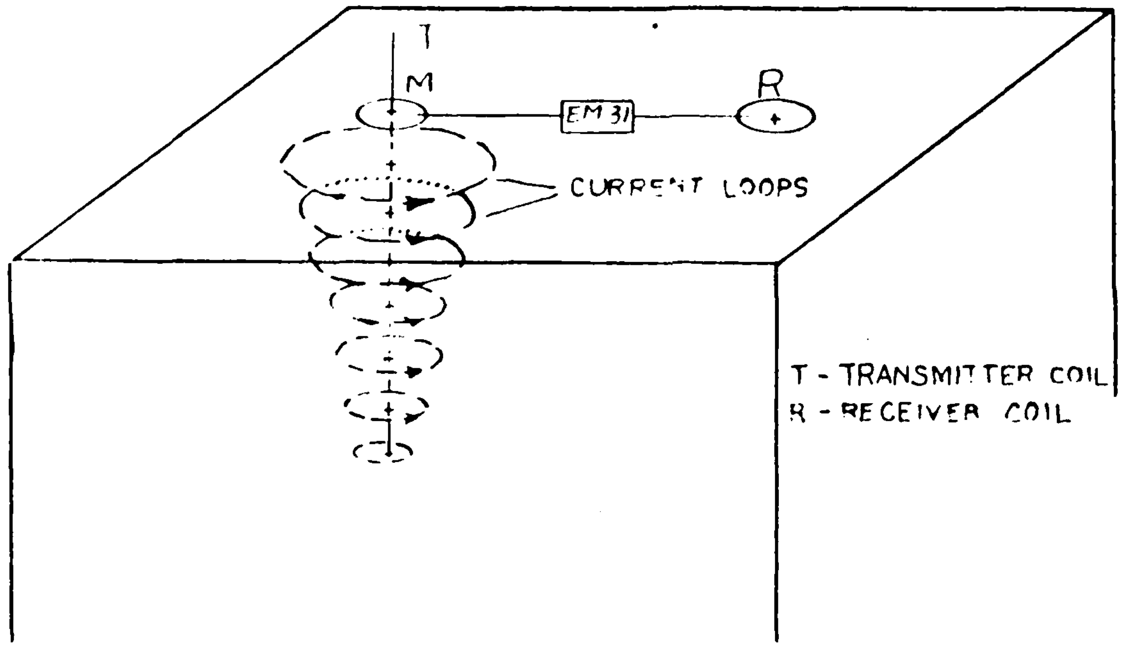
EM-31 Conductivity Meter

The EM-31 is an electromagnetic measurement technique that measures the bulk electrical properties of the ground. Changes in the electrical conductivity can occur as a result of changes of soil type, soil water content, rock type, fractures in rock and mineralization in rocks. The technique is effective for mapping geohydrologic changes in the ground, and also for mapping subsurface contamination from landfills and waste impoundment sites.

The electrical conductivity is inversely related to the electrical resistivity of the ground. An advantage of the EM-31 measurements to resistivity measurements is that no electrodes in contact with the ground are necessary; thus the measurements are obtained simply and rapidly.

The basic principle of the EM-31 is simple. Referring to Figure 1, a transmitter coil, T, located at one end of the instrument induces circular eddy current loops in the ground. The magnitude of any one of the current loops is directly proportional to the terrain conductivity in the vicinity of the loop. Each one of the current loops generates a magnetic field which is proportional to the value of the current flowing within the loop. A part of the magnetic field from each loop is intercepted by the receiver coil, R, and results in an output voltage which is therefore linearly related to the conductivity of the ground.

The EM-31 instrument operates at 10 KHz and the transmitter loop and receiver loop are separated by a 3.7 meter-long boom. The instrument is powered by an internal battery and the overall weight of the instrument is 9 Kg. The conductivity is read out on a meter on the front panel. The ground conductivity measurement depth is about five meters when operated with the coils oriented vertically and about two meters with the coils oriented horizontally. We carried out the conductivity measurements with the coils in both orientations and thus have an estimate of the conductivity above and below the water table at the sites at Myrtle Beach AFB. We shall have a look at the results obtained at the Myrtle Beach AFB.



EarthTech Research Corporation		
FIGURE 1 INDUCED CURRENT FLOW IN GROUND		
SIZE A	CODE IDENT NO.	DRAWING NO.
SCALE		SHEET OF

Pipeline Site

We shall begin by looking at the data from the spill that occurred at the Myrtle Beach Pipeline Corporation site. Figure 2 shows the conductivity data with the coils oriented vertically (deep sounding) and the coils oriented horizontally (shallow sounding) along a line running north from the valves in the tank area out 200 feet past the old railroad bed as shown on the sketch. We note that the conductivity decreases as we move from the valves across the old railroad bed. We know there is spilled fuel on the south side of the road, and we do not expect any on the north side of the road.

Figure 3, like Figure 2, shows the conductivity measurements obtained along the old railroad bed running both east and west from where the pipeline crosses under the railroad bed. We note that the conductivity is significantly higher from the culvert at about 250 feet west to about 50 feet east of the pipeline. The spill was not expected to travel to the west of the spill, but the conductivity measurements indicate that it may have migrated west towards the small stream. We know that some of the fuel traveled east towards the drainage ditch from the monitoring wells in the area. It appears that none of the fuel lies under the road from about 50 feet east of the pipeline running east towards the drainage ditch.

Figure 4 shows the results of the conductivity measurements running north/south on a line to the west of the drainage ditch. The conductivity increases significantly around the gully area about 150 feet south of the old railroad bed and remains highly conductive to about halfway along the parking lot of Building 519, located on Avenue "D". There is a fuel odor in the area of the borehole and pit located about 200 feet south of the old railroad bed.

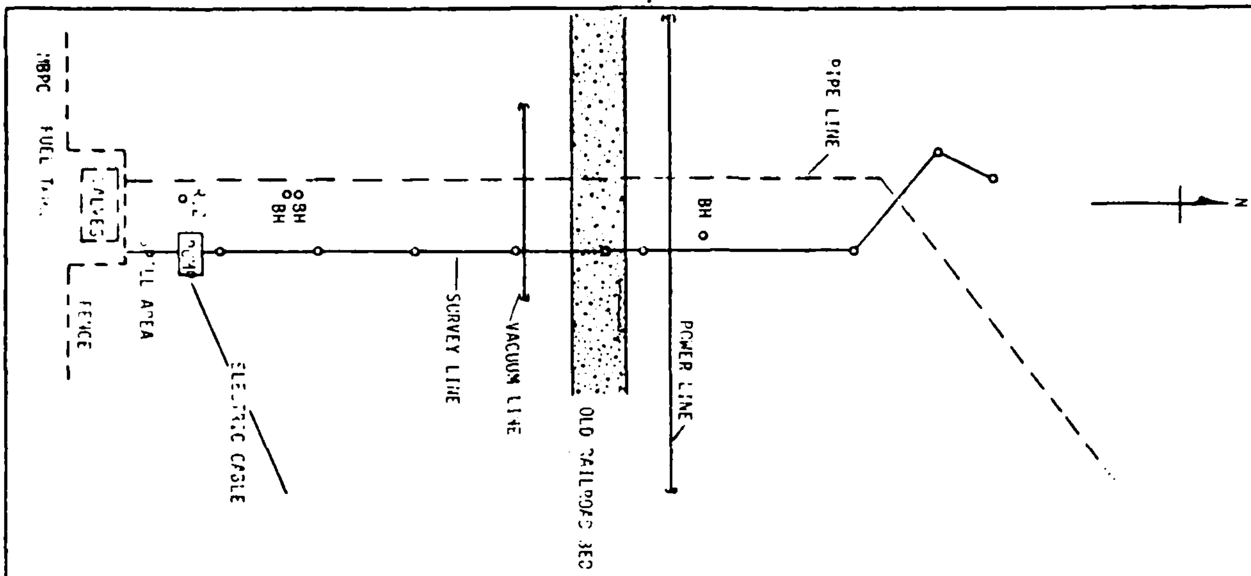
A similar line was run on the east side of the drainage ditch at shown in Figure 5. We note a low conductivity along this line indicating no leaked fuel in the ground as we expect. There is an exception though in the area of the stream coming from the POL site. There is an odor of fuel in the area, and we suspect that fuel has spilled into the stream sometime or other.

POL Site

EM-31 surveys were carried out in the east area of the POL site and also to the southeast of the site. About 10,000 gallons of fuel were spilled about 18 years ago from an old tank which no longer exists. Figure 6 shows a sketch map of the POL site where the conductivity surveys were carried out. Figure 7 shows the conductivity data from the six survey lines run in the area. The conductivity on all the lines are very similar, and no anomalous areas were found indicating that there is probably little or no significant residual concentrations of fuel remaining in the ground after the spill 18 years ago.

Building 357

Figure 8 shows the location of the survey line run to the east of Building 357. The conductivities are also shown on Figure 8. No significant conductivity anomalies are seen along this line. Note that the conductivity values along this line, at the POL site and where we do not expect any fuel at the tank site all lie between 10 and 20 millimhos per meter for the deep soundings, and five and ten millimhos per meter for the shallow soundings.



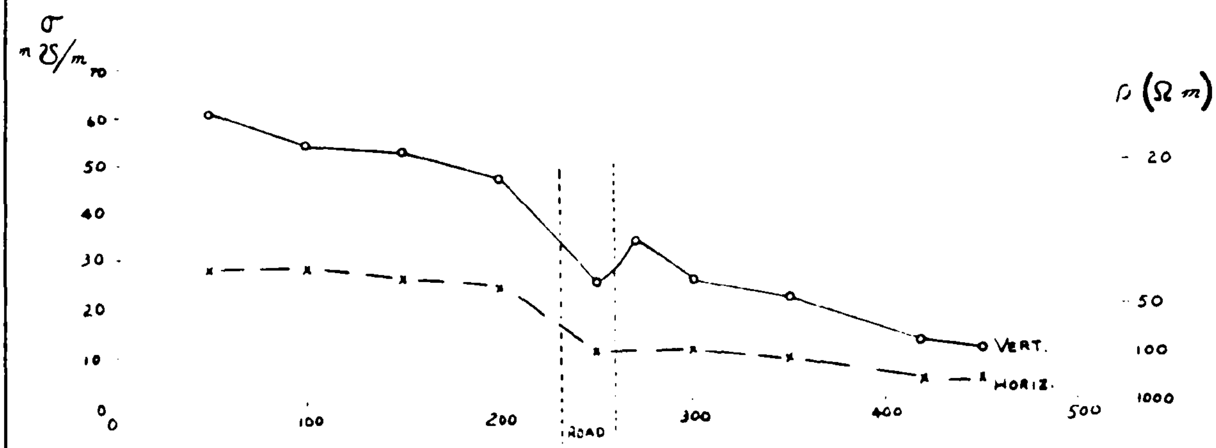
EarthTech Research Corporation

MYRTLE BEACH PIPE LINE
SPILL AREA

SIZE	CODE IDENT NO.	DRAWING NO.
A		

SCALE		SHEET OF

FIGURE 2 a)



EarthTech Research Corporation

Myrtle Beach Pipe Line
Spill Area

SIZE	CODE IDENT NO.	DRAWING NO.
A		

		SHEET OF

FIGURE 2 b)

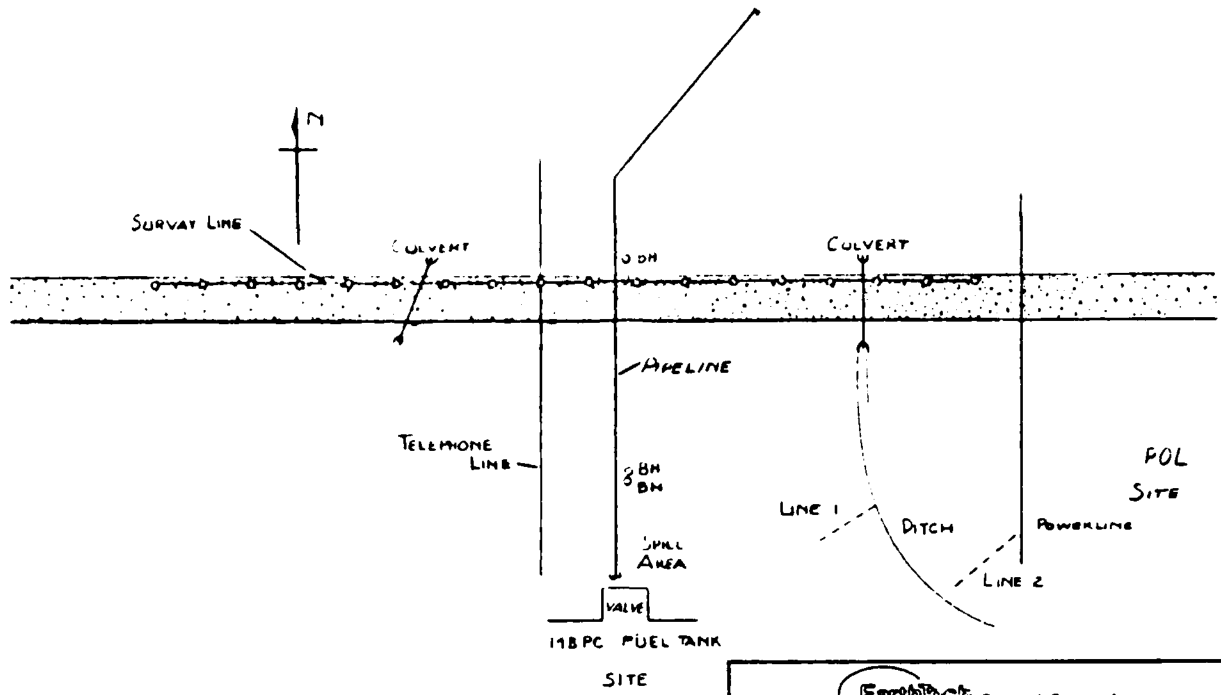


FIGURE 3 a)

EarthTech Research Corporation

MYRTLE BEACH PIPE LINE
OLD RAILROAD BED

SIZE	CODE IDENT NO.	DRAWING NO.
A		

SCALE | | SHEET OF

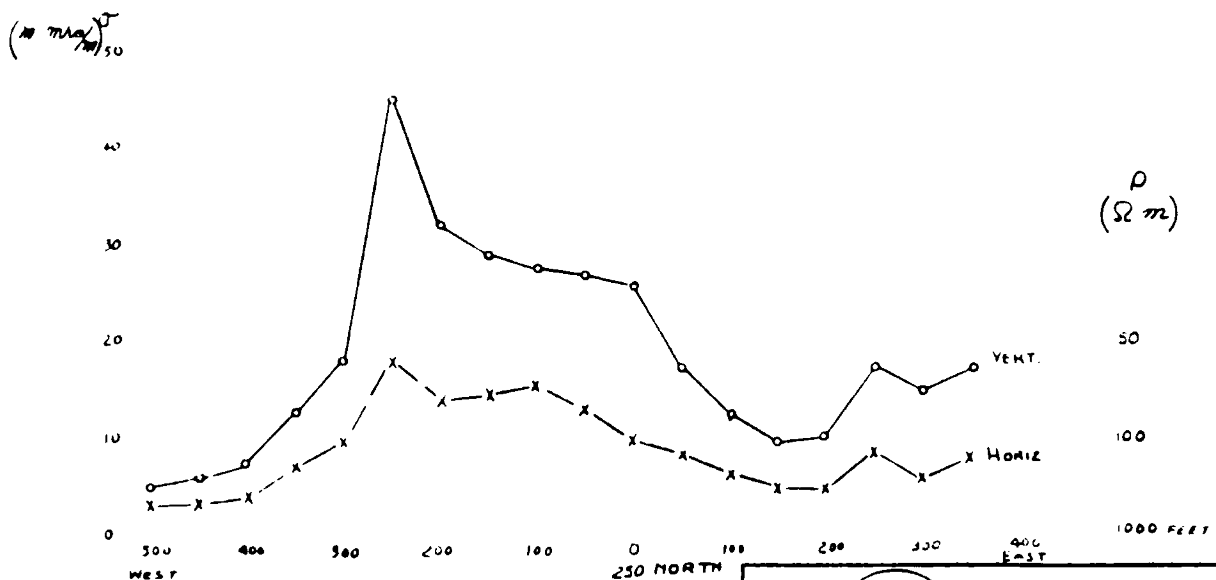


FIGURE 3 b)

EarthTech Research Corporation

MYRTLE BEACH PIPELINE
OLD RAILROAD BED

SIZE	CODE IDENT NO.	DRAWING NO.
A		

SHEET OF

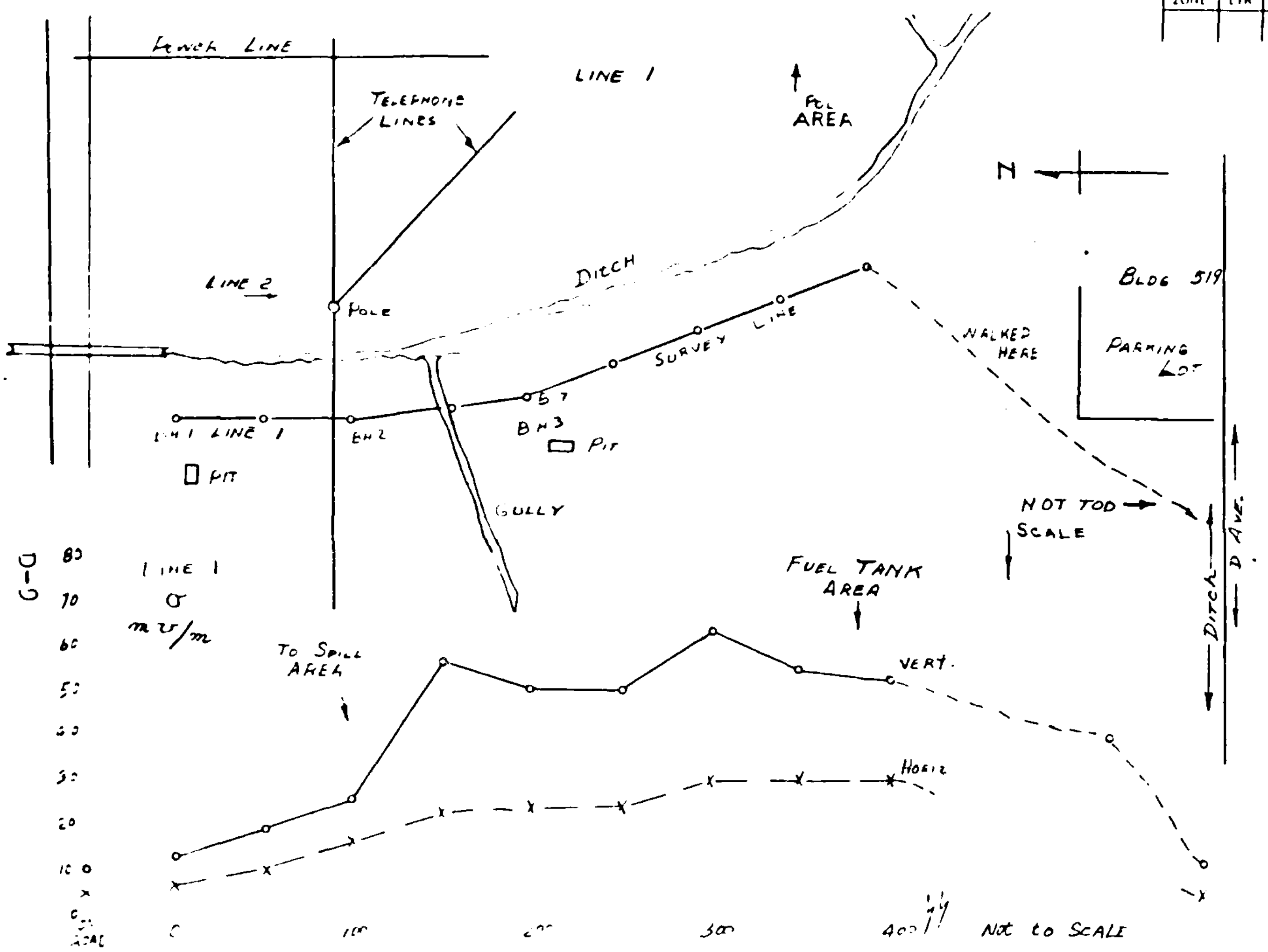


FIGURE 4

Earth Research Corporation		
MYRTLE BEACH PIPELINE SPILL AREA		
SIZE B	CODE IDENT NO	DRAWING NO
SCALE		SHEET 01

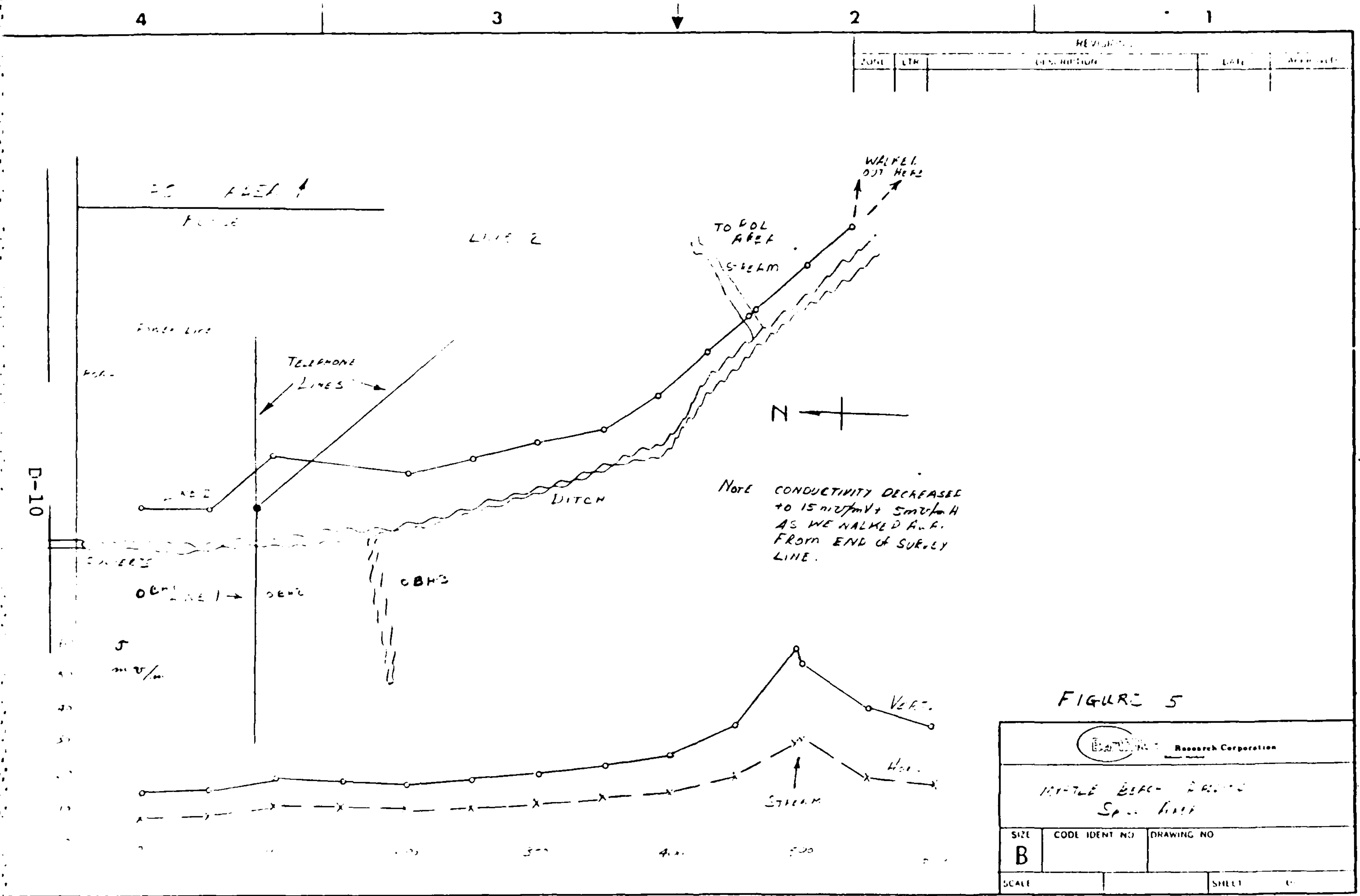
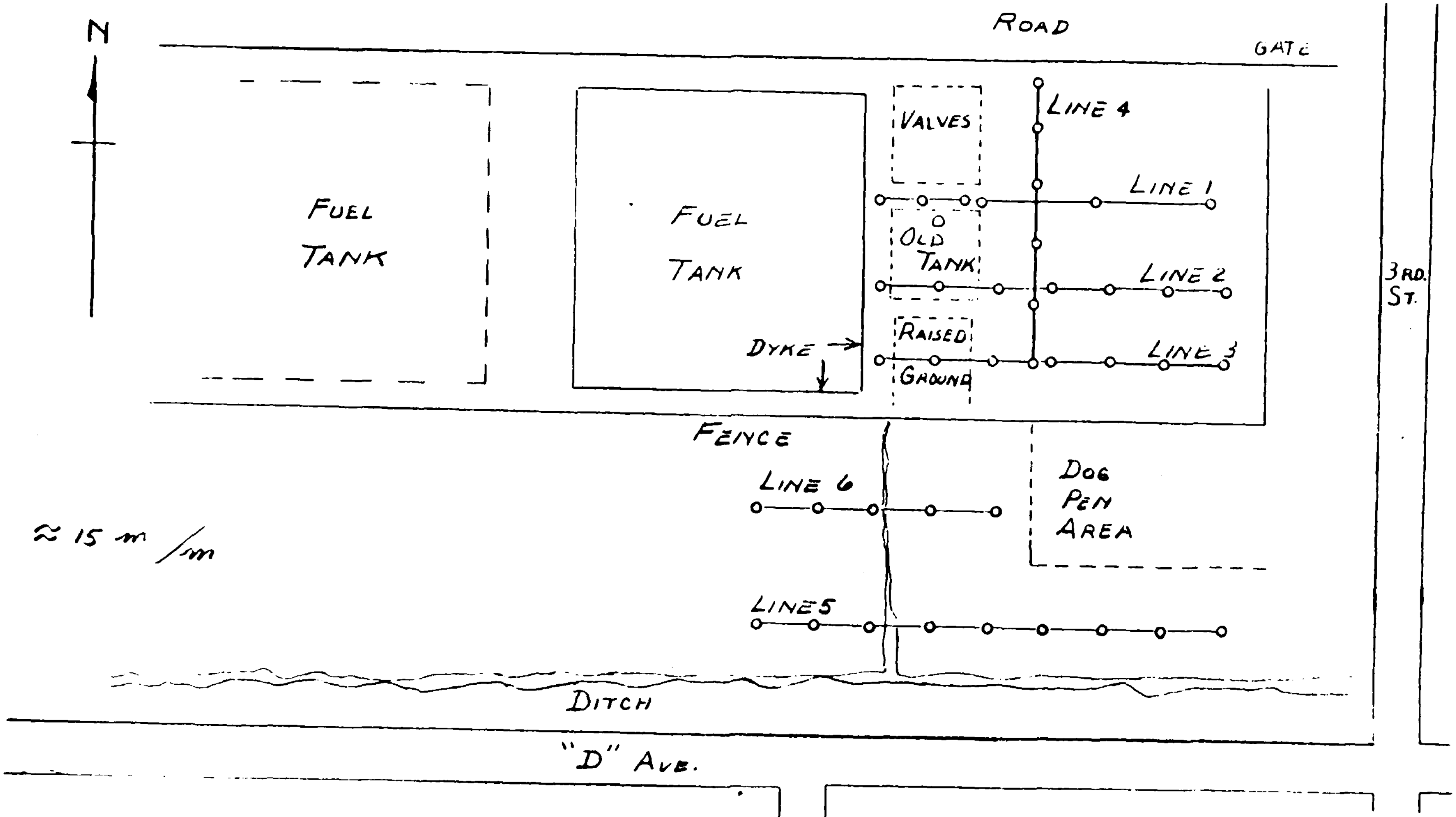

WALKED OUT HERE
TO POL AREA
STREAM
LINE 2
DITCH
TELEPHONE LINES
CBH3
N
NOTE CONDUCTIVITY DECREASES to 15 mmho/m AS WE WALKED FROM END OF SURVEY LINE.
VERT.
HOR.
STREAM
Research Corporation
SIZE
B
CODE IDENT NO
DRAWING NO
SCALE
SHEET

FIGURE 5



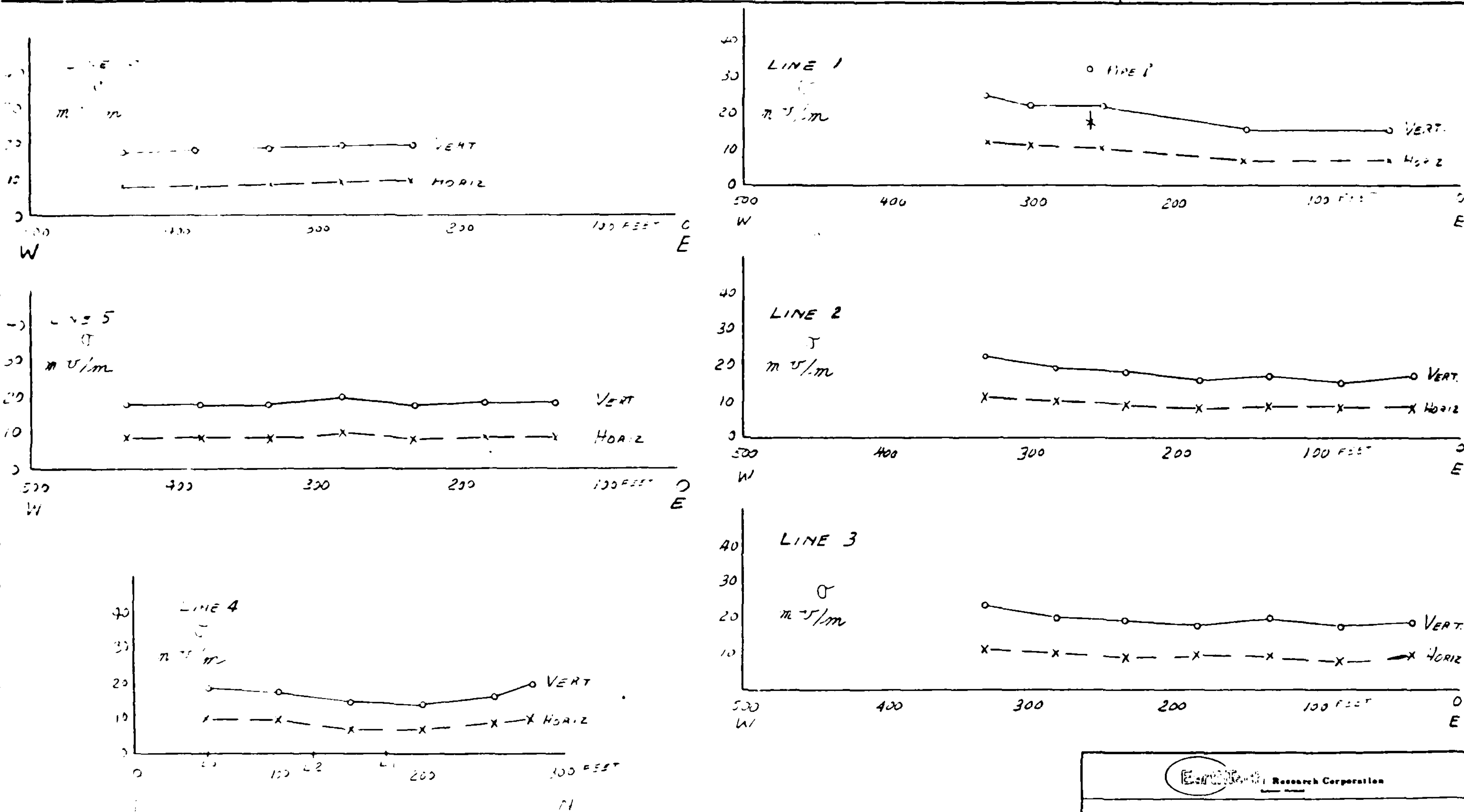
EarthTech Research Corporation

POL SITE

SIZE	CODE IDENT NO.	DRAWING NO.
A		

SCALE | | SHEET OF

FIGURE 6



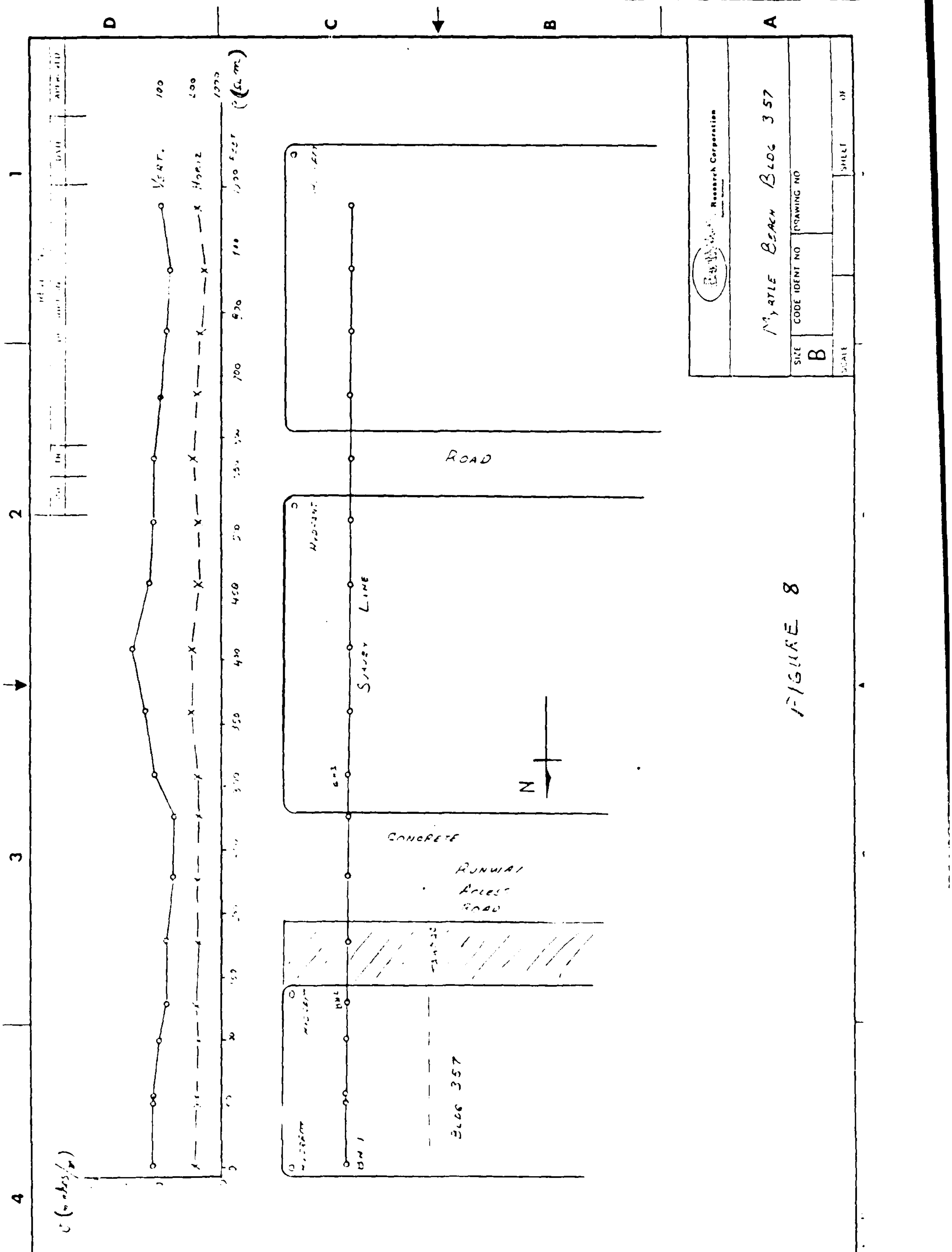
Research Corporation

POL SITE

SIZE B | CODE IDENT NO | DRAWING NO

SCALE | SHEET OF

FIGURE 7


Research Corporation
Myrtle Beach Bldg 357
CODE IDENT NO
DRAWING NO
SIZE
B
SCALE
SHEET
OF
FIGURE 8
Vert.
Horiz.
Road
Survey Line
Concrete
Runway
Arrest
Road
Bldg 357
N

The electrical conductivity of the soil in the Myrtle Beach AFB seem to be very consistent except where we know or suspect spilled fuel to be present. There is not, at first glance, any significant correlation between the conductivity measurements and the geologic logs that indicate areas of increased clay levels in the sandy soil on the base. The reason for this lack of correlation is not clear to us at this time, and the amount of clay and its continuity in the sandy soil are not known to the author.

Summary

The EM-31 conductivity surveys carried out at the Myrtle Beach AFB indicate that the electrical conductivity of the ground increases in areas where spilled fuel is known to exist. The extent of the spilled fuel at the Myrtle Beach Pipeline Corporation fuel tank area appears to extend further west than expected along the old railraod bed. There is also a high conductivity area extending along the west side of the drainage ditch towards Building 519 on Avenue "D". There is not a strong correlation at first glance between the conductivity measurements and the geologic logs showing areas of varying clay contents.

No electrical conductivity anomalies were found in the POL site indicating that the fuel spill from the old fuel tank from 18 years ago has either disappeared or is of too low a concentration to be detected by the EM-31 terrain conductivity meter. There is an electrical conductivity anomaly by the stream flowing from the southwest side of the POL site into the drainage ditch. There is an odor of fuel in this area. No electrical conductivity anomalies were observed along the survey line run to the east of Building 357.

Recommendations

1. Carry out further EM-31 conductivity surveys at the Myrtle Beach Pipeline Corporation fuel tank area to map the extent of the observed conductivity anomaly. This will help Geraghty and Miller, Inc. decide the optimum placement of the ground water monitoring wells.

2. Carry out a depth profile using the EM-31 to help identify more precisely the depth at which the spilled fuel exists, and to help identify variations in soil type.

3. Obtain electrical conductivity measurements of the uncontaminated ground water and also of the ground water that is known to be contaminated by the fuel.

4. Check the geologic logs against the electrical conductivity measurements to determine if the electrical measurements are primarily sensitive to variations of soil type, ground water level, or spilled fuel in the ground. The actual percentage of the clay and sand in the geologic logs needs to be determined. The extent and continuity of the clay also needs to be determined if possible. Electrically the ground appears to be homogeneous except in areas where we expect that spilled fuel exists or might exist.

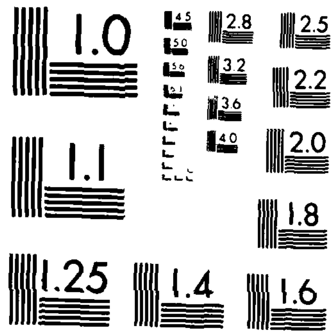
AD-A156 721 INSTALLATION RESTORATION PROGRAM PHASE II PROBLEM CONFIRMATION AND QUANTI..(U) RESEARCH TRIANGLE INST RESEARCH TRIANGLE PARK NC JAN 85 F33615-80-D-4000 2/2

UNCLASSIFIED F/G 8/8 NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Costs incurred on preliminary survey at Myrtle Beach AFB

The first Form 60 gives the breakdown of costs incurred for Davis and Dolinger to carryout a preliminary EM-31 survey at the Myrtle Beach AFB. The cost for this work which includes the data report submitted here is $2,268.09. The burdened labor costs are the same as those which are accepted at present in our projects with EPA, DOE, and the Bureau of Mines.

Cost to carryout another survey day at Myrtle Beach AFB

Another day of surveying using the EM-31 is necessary to accomplish recommendations 1) and 2) in the area around the Myrtle Beach Pipeline fuel tank. A day and a half is needed for data reduction, data interpretation, and report writing. The second Form 60 gives a breakdown of the costs and the estimated cost is $2,732.00. The total cost of the geophysical surveys at the Myrtle Beach AFB will be about $5,000.00

I hope that the above report of the geophysical surveys using the EM-31 at the Myrtle Beach AFB and the recommendations for future work are satisfactory. If you have any questions, please do not hesitate to contact me. We look forward to hearing from you soon.

Sincerely,

EARTHTECH RESEARCH CORPORATION

Les Davis

J. L. Davis
Senior Geophysicist

JLD:cjs

Enclosures

Part D-2: Final Geophysical Survey Conducted in the Pipeline Spill Area

EarthTech Research Corporation

December 30, 1982

Geraghty and Miller, Inc.
844 West Street
Annapolis, MD 21401

Attention: Mr. Jeff Sgambat

Re: Ground conductivity measurements carried out by EarthTech, Inc. at the Myrtle Beach Pipeline Corporation tank farm.

Dear Jeff:

This report contains excellent quality conductivity contour maps that may correlate with the extent in the ground of the JP4 fuel spill that occurred in May, 1982. The data from the twelve existing boreholes in the area are inconclusive. We recommend that more detailed soils data, chemical data, especially sensitive to the JP4 fuel, and permeability data be obtained from at least six 20-foot deep boreholes.

INTRODUCTION

EarthTech, Inc., has carried out conductivity surveys at the Myrtle Beach Air Force Base in cooperation with Geraghty and Miller, Inc., to help map the extent of fuel spills on the base and to help Geraghty and Miller decide upon the optimum locations for groundwater monitoring wells.

6655 Amberton Drive, Baltimore, Maryland 21227 / (301) 796-5200

The preliminary geophysical surveys carried out in October, 1982 by EarthTech indicated that there were no significant conductivity anomalies at the P.O.L. site, where 10,000 gallons of fuel were spilled in 1964, nor beside the runway near Building 357, where fuel was apparently detected in a well adjacent to the building five years ago by the Municipality of Myrtle Beach. A very significant conductivity anomaly was observed near the Myrtle Beach Pipeline Corporation tank farm where more than 120,000 gallons of JP4 fuel were spilled during May of 1982. The extent of the area of the high electrical conductivity which correlated strongly with the known area of the spilled fuel extended further to the northwest and the southeast than was expected. The objective of the electrical conductivity survey reported here was to map the extent of the high conductivity area around the Myrtle Beach Pipeline Corporation (MBPC) tank farm.

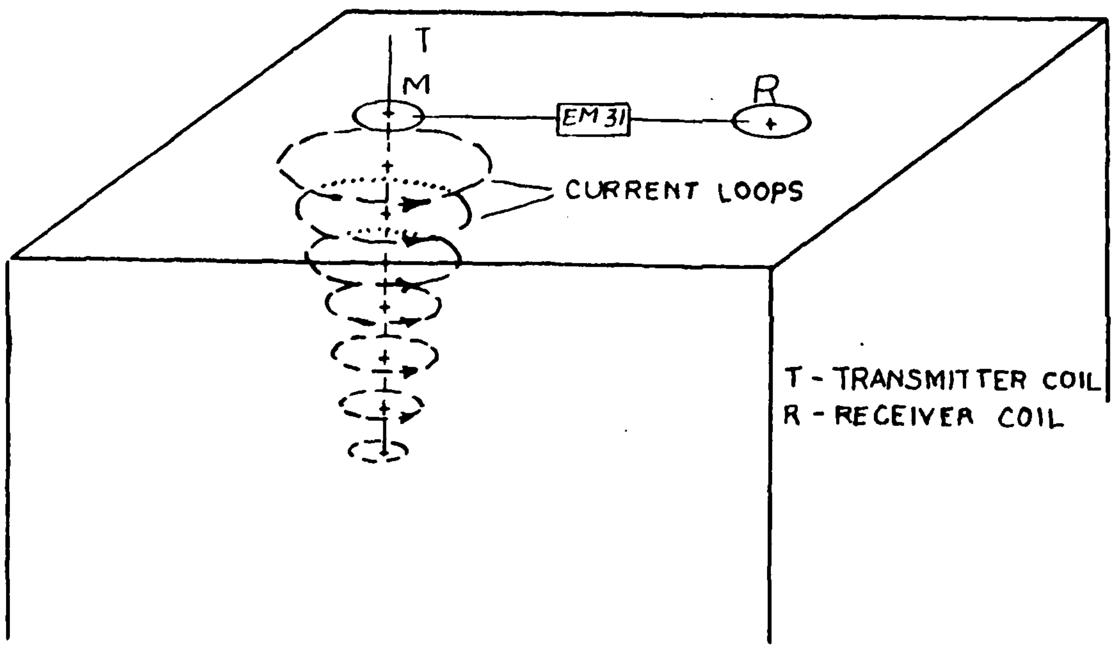
In this report we discuss first how the EM-31 conductivity meter measures the ground conductivity, then the location of the geophysical survey lines and finally the results of the conductivity measurements. Conclusions are made and recommendations based on the surveys carried out are offered.

EM-31 Conductivity Meter

The EM-31 is an electromagnetic measurement technique that measures the bulk electrical properties of the ground. Changes in the electrical conductivity can occur as a result of changes of soil type, soil water content, rock type, fractures in rock and mineralization in rocks. The technique is effective for mapping hydrogeologic changes in the ground, and also for mapping subsurface contamination from waste impoundment sites.

The electrical conductivity is inversely related to the electrical resistivity of the ground. An advantage of the EM-31 measurements to resistivity measurements is that no electrodes in contact with the ground are necessary; thus the measurements are obtained simply and rapidly.

The basic principle of the EM-31 is simple. Referring to Figure 1, a transmitter coil, T, located at one end of the instrument induces circular eddy current loops in the ground. The magnitude of any one of the current loops is directly proportional to the terrain conductivity in the vicinity of the loop. Each one of the current loops generates a magnetic field which is proportional to the value of the current flowing within the loop. A part of the magnetic field from each loop is intercepted by the receiver coil, R, and results in an output voltage which is linearly related to the conductivity of the ground.



EarthTech Research Corporation

FIGURE 1

INDUCED CURRENT FLOW IN GROUND

SIZE	CODE IDENT NO.	DRAWING NO.
A		

SCALE		SHEET	OF

The EM-31 instrument operates at 10 KHz and the transmitter loop and receiver loop are separated by a 3.7 meter-long boom. The conductivity is read out on a meter on the front panel. The ground conductivity measurement depth is about five meters when operated with the coils oriented vertically and about two meters with the coils oriented horizontally. We carried out measurements with the coils in both orientations and thus have an estimate of the conductivity above and below the water table at the sites at the MBPC tank farm site. We shall have a look at the locations where the conductivity measurements were obtained and then a look at the results.

Conductivity Survey Location

Figure 2 is a map showing the locations where the electrical conductivity measurements were obtained in the area of the MBPC tank farm. The MBPC tank farm is located just north of Avenue "D" and northwest of 4th Street on the Myrtle Beach AFB. The JP4 tank is shown by a large circle at 150S. The pipeline enters the tank farm from the north at the valves located at the grid origin as shown. The location of the old railroad bed, the East Ditch and the P.O.L. site are also shown. The location of eleven boreholes drilled after the JP4 fuel spill occurred are also shown and identified.

The origin of the survey grid is located at the north gate of the MBPC tank farm just by the valves where the fuel spill occurred. A 100-foot tape was used to determine the location of each survey station. Most survey stations are located along roads, on lines cut through the brush beside the ditch or on lines between permanent markers, thus enabling us to relocate the survey stations.

The conductivity measurements were carried out at each location marked by a large square shown on Figure 2. Measurements were made with the coils oriented vertically and horizontally at each station. The conductivity meter was monitored between each survey location to determine if any anomalies occurred between the survey stations. If anomalies were observed and they did not correlate to either underground pipes or overhead cables then additional survey points were added. There are about 200 measurement stations shown on Figure 2. Most of the measurements were obtained in a 600-foot by 600-foot area centered around the valves at the MBPC tank farm where the JP4 fuel spill occurred. All the measurements were obtained by L. Davis and M. Dolinger of EarthTech, Inc. Most measurements shown in this report were obtained on December 1, 1982. We shall look at the results of the conductivity measurements.

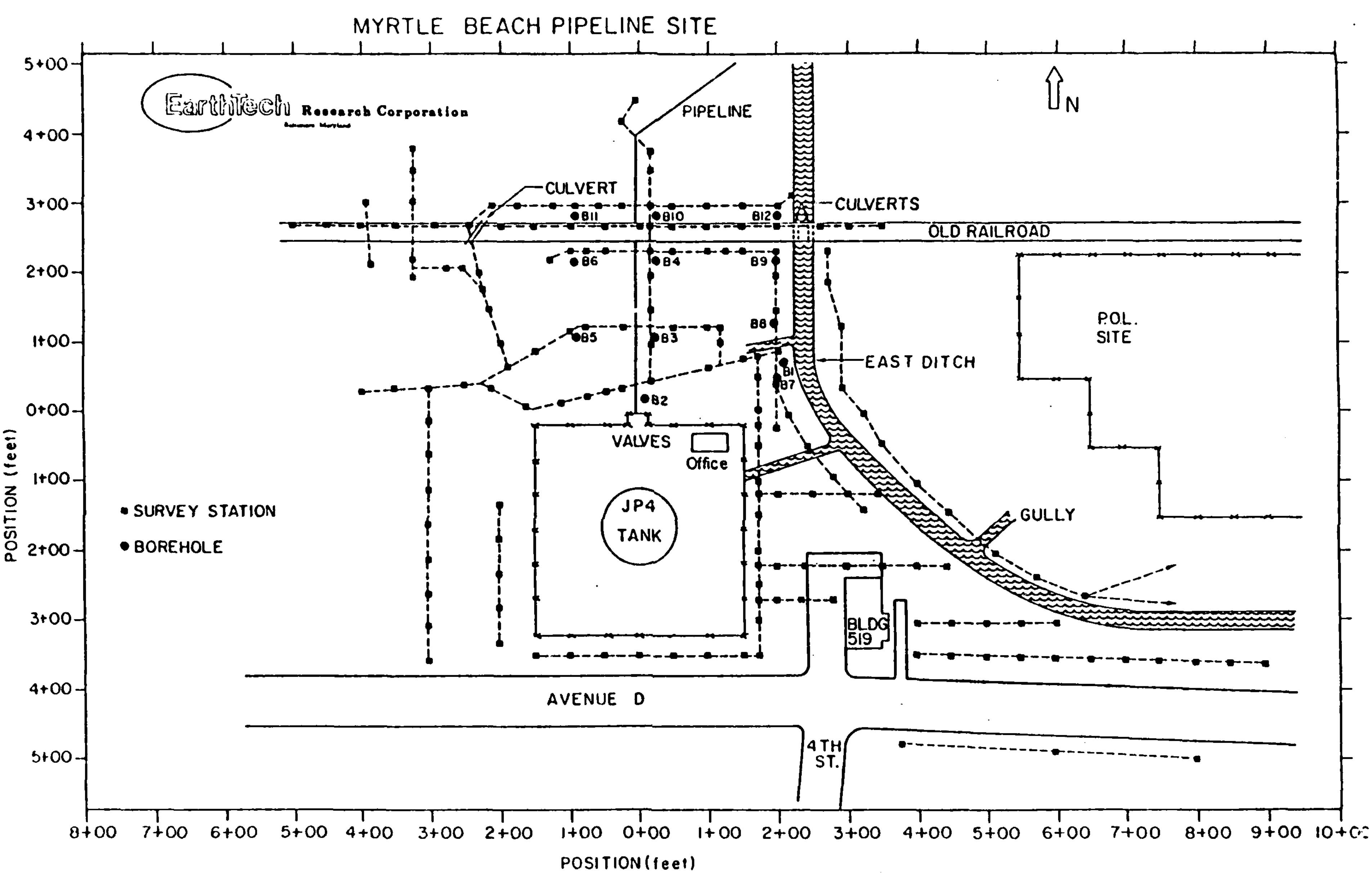


Figure 2. Map of the MBPC tank farm area showing the locations of the survey stations marked ■ .

Conductivity Measurements

In this section we present the results of the conductivity measurements obtained at each survey station, present contour maps of the conductivities, and then discuss the results.

Figure 3 shows the conductivity measurements obtained with the coils oriented vertically at each survey station. These measurements represent the bulk conductivities over a depth of 15 feet. Figure 4 shows the conductivity measurements obtained with the coils oriented horizontally at each survey station. These measurements indicate the bulk conductivities over the a depth of 5 feet. It is reasonable to assume that the horizontal coil orientation of the EM-31 measures the conductivity of the soil above the water table and that the vertical coil orientation measures the conductivity of the saturated soil below the water table. This assumption is not generally the rule, but only a good approximation for the conditions in the MBPC tank farm area.

Figure 5 is a contour map obtained around the MBPC tank farm with the coils vertically oriented. Figure 6 is a similar contour map obtained with the coils horizontally oriented.

Discussion

Typically in the Myrtle Beach AFB the background conductivity levels were less than 20 millimhos per meter with the coils of the EM-31 oriented vertically and less than 10 millimhos per meter with the coils oriented horizontally. These conductivities are equivalent to resistivities of 50 and 100 ohm meters respectively. It is interesting to note that the ground is quite conductive for a sandy soil, but this is probably due to the area being in close proximity to the sea.

The area of the highest conductivities occurs around the valves of the MBPC tank farm where the spill occurred. The highest conductivities measured (70 millimhos per meter) during the survey occurred at 100N, 100E, or about 140 feet to the northeast of the valves.

The conductivities generally decrease to the background levels as we approach the old railroad bed except to the northwest at 275N, 250W where a culvert goes under the old railroad bed. A French drain is located on the south side of the old railroad bed at 250N and extends from about 100 E to 100W near borehole 6. This French drain is used to collect water and fuel from the soil.

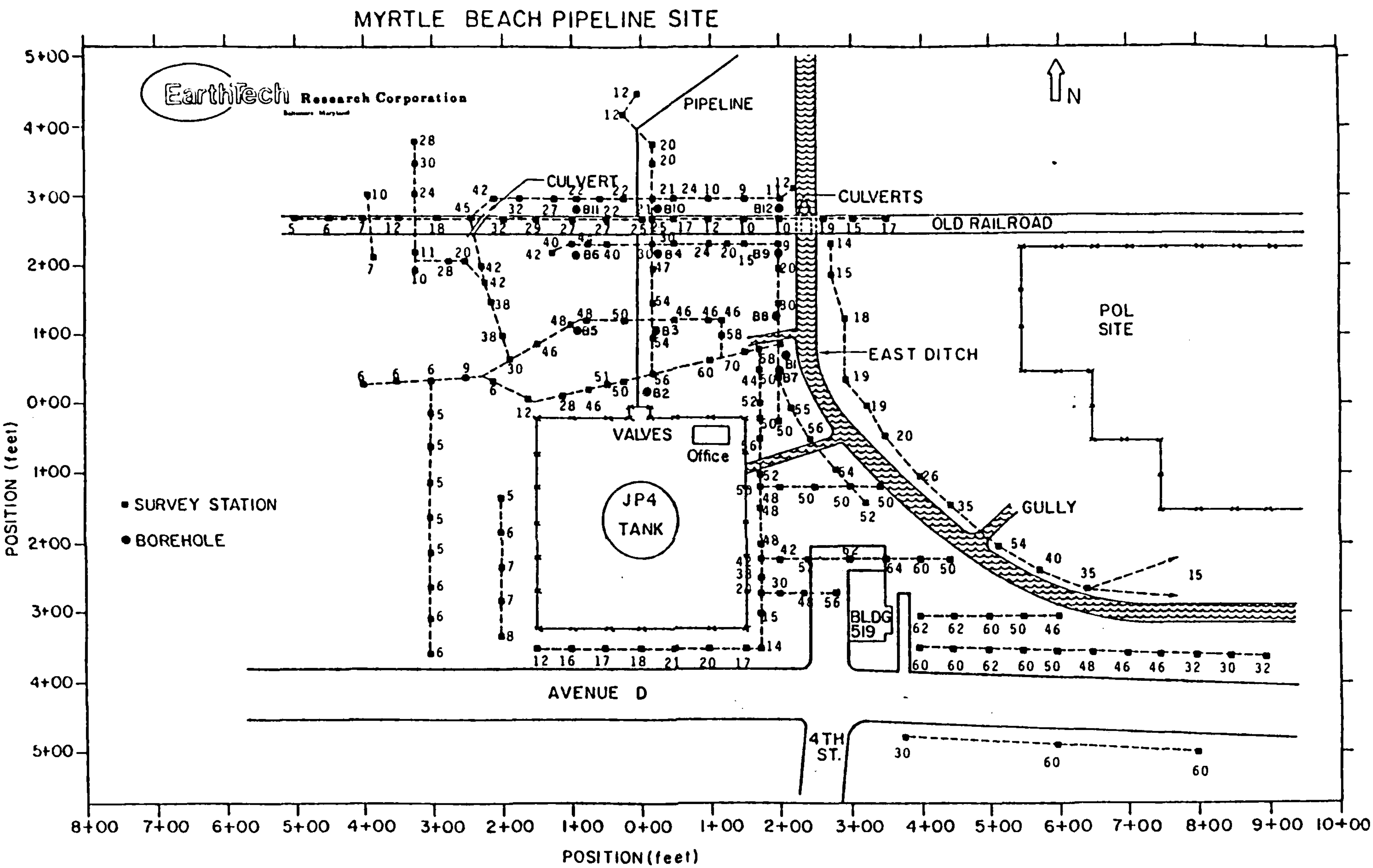


Figure 3. Conductivity measurements in millimhos per meter obtained with the EM-31 coils vertically oriented in the MBPC tank farm area.

MYRTLE BEACH PIPELINE SITE

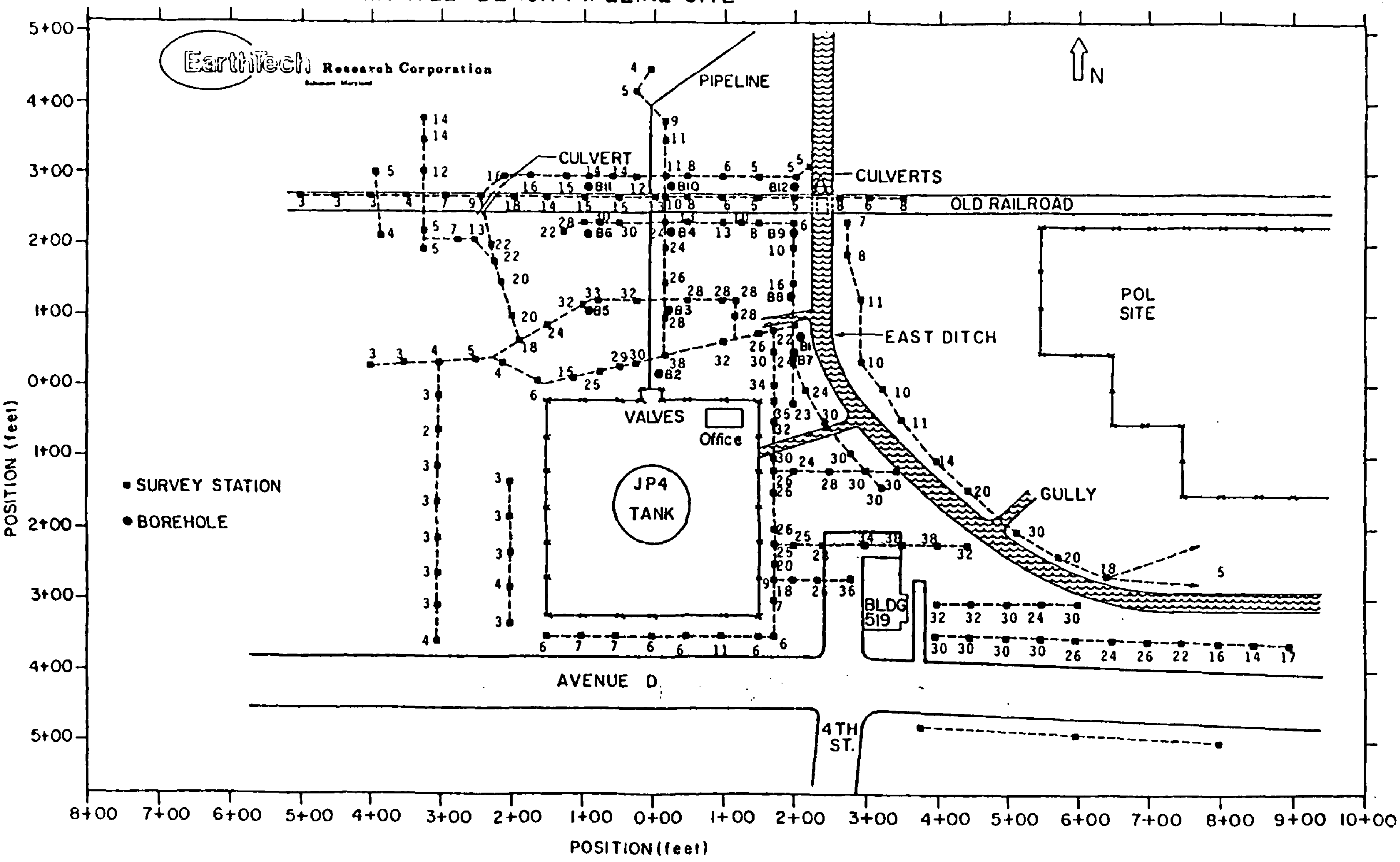


Figure 4. Conductivity measurements in millimhos per meter obtained with the EM-31 coils horizontally oriented in the MBPC tank farm area.

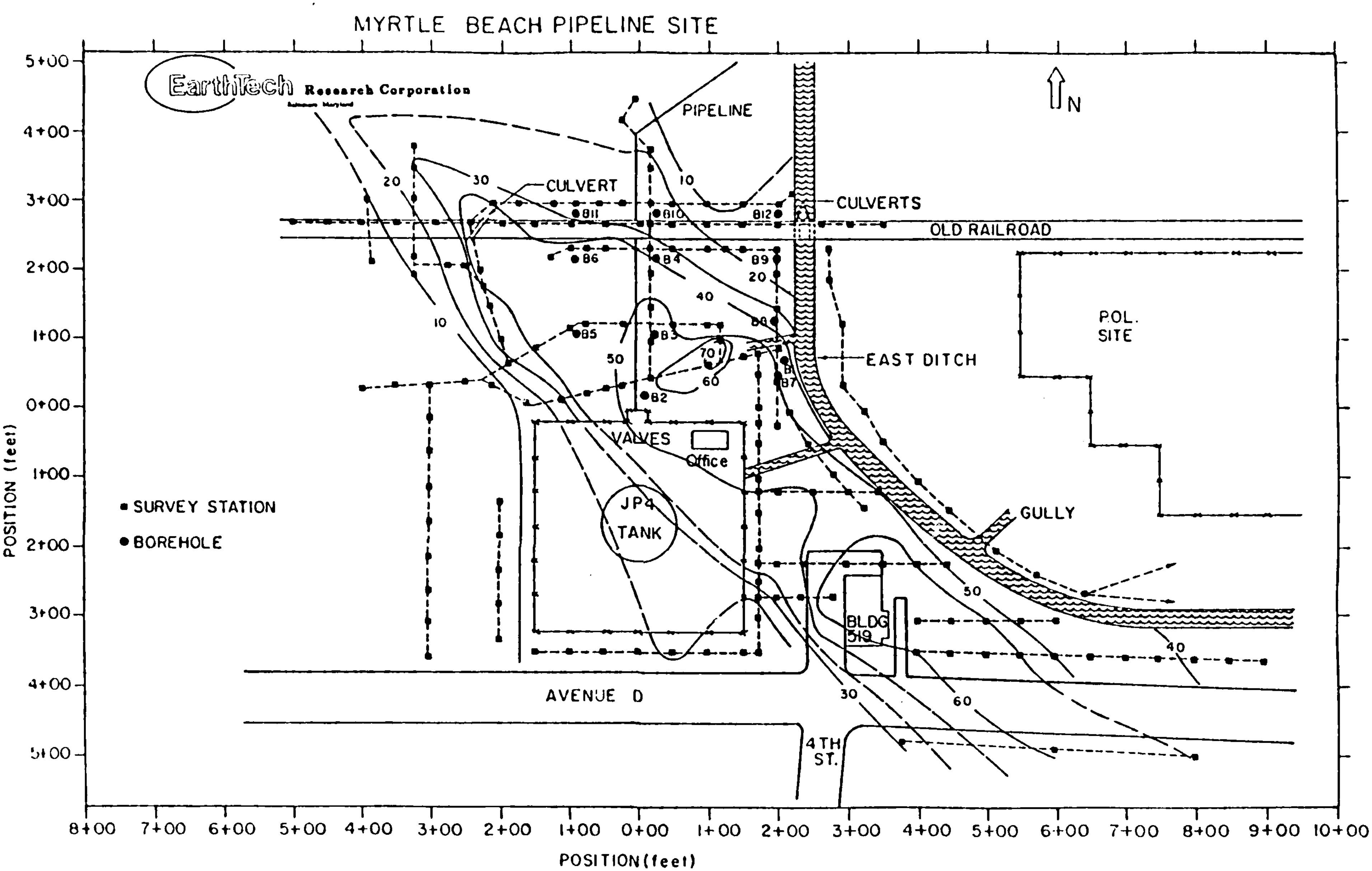


Figure 5. A contour map of conductivity measurements in millimhos per meter with the EM-31 coils vertically oriented in the MBPC tank farm area.

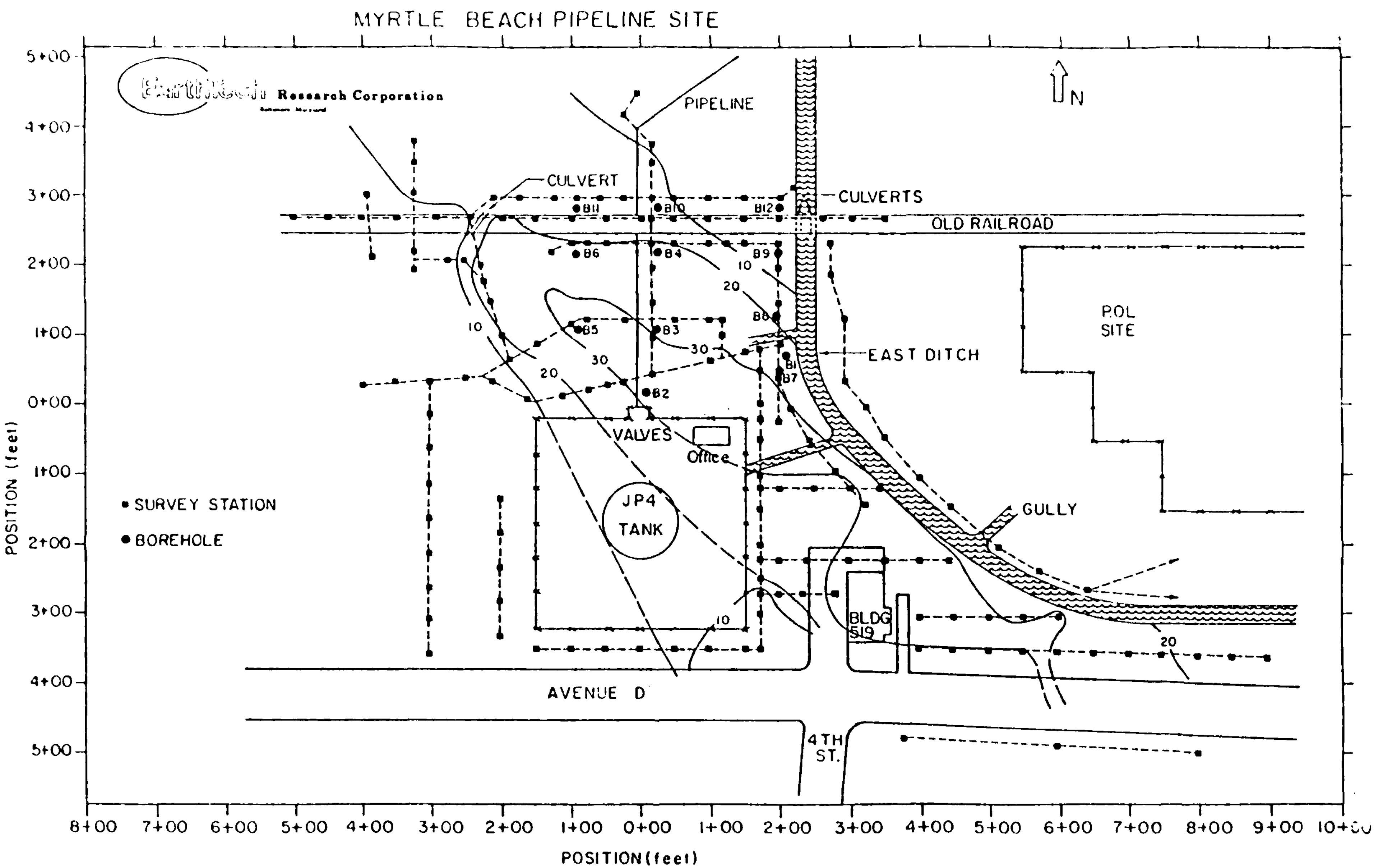


Figure 6. A contour map of conductivity measurements in millimhos per meter with the EM-31 coils horizontally oriented in the MBPC farm area.

Fire Training Areas #1 and #2: 02/83 Data Set

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
1	4.83	456	9.9	Benzene 0.035 Chloroform 0.002 Toluene 0.010 Ethylbenzene <0.002
2	4.58	238	3.3	NA
3	4.70	281	2.4	NA
4	5.79	509	27.3	Chloroethane 0.016 Chloroform 0.003 Benzene <0.001 Methylene chloride <0.001
5	5.86	546	9.7	NA
6	5.92	274	2.7	NA
7	5.75	210	14.3	NA
8	5.93	128	3.2	NA
9	6.74	456	2.7	NA

NA = Not Analyzed

TOC = Total Organic Carbon

Fire Training Areas #1 and #2: 12/82 Data Set

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
1	0.050	10.0	<0.050	13.2	ND	123.1	33.7	0.106	30.8	NA	NA	NA	ND	NA	0.03	NA	ND
2	0.013	2.9	<0.050	12.5	ND	52.0	15.8	0.043	18.7	NA	NA	NA	0.008	NA	0.07	NA	0.001
3	0.024	5.2	<0.050	19.6	ND	50.4	17.2	0.099	22.6	NA	NA	NA	ND	NA	0.02	NA	0.010
4	0.017	26.0	<0.050	4.2	ND	87.7	52.8	0.322	30.0	NA	NA	NA	ND	NA	0.01	NA	ND
5	0.093	6.0	<0.050	8.0	ND	110.9	43.7	0.129	57.2	NA	NA	NA	0.009	NA	ND	NA	ND
6	0.044	2.5	<0.050	9.3	ND	42.3	5.2	0.097	20.6	NA	NA	NA	ND	NA	0.01	NA	ND
7	0.049	8.1	<0.050	48.1	ND	32.2	44.6	0.169	30.6	NA	NA	NA	ND	NA	0.01	NA	0.006
8	0.018	6.3	<0.050	8.1	ND	19.6	50.1	0.015	11.3	NA	NA	NA	ND	NA	ND	NA	0.006
9	0.039	4.0	<0.050	42.0	ND	24.6	1.5	0.112	24.5	NA	NA	NA	0.002	NA	ND	NA	0.002

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides
TOC = Total Organic Carbon

Part G-1: Fire Training Areas #1 and #2

12/82 Data Set: Samples Collected During
December 8, 9, and 10, 1982

02/83 Data Set: Samples Collected During
February 18 and 19, 1983

APPENDIX G

RESULTS OF LABORATORY ANALYSES OF GROUNDWATER SAMPLES COLLECTED NEAR IDENTIFIED POTENTIAL SOURCE AREAS AT MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

Part G-1: Fire Training Areas #1 and #2

Part G-2: Landfill #3/Weathering Pit #2

Part G-3: Fire Training Area #3

Part G-4: Weathering Pit #1

Part G-5: POL Area

Part G-6: Landfills #1 and #4

Part G-7: Flight Line Area

RESULTS OF FIELD ANALYSES CONDUCTED ON GROUNDWATER (Cont.)

Well Number	Specific Conductivity (umhos/cm) Dec 82	Feb 83	Jun 83	pH (standard units) Dec 82	Feb 83	Jun 83	Temperature (°C) Dec 82	Feb 83	Jun 83
Weathering Pit #1									
GM-23	140	120	-	5.9	5.7	-	19	15	-
GM-24	160	170	140	5.7	5.4	5.5	19	15	21
GM-25	215	145	-	6.3	5.9	-	20	16	-
GM-26	85	90	-	5.8	6.2	-	17	14	-
GM-27*	330	390	-	6.9	7.1	-	18	18	-
GM-43*	**	**	325	**	**	6.5	**	**	20
GM-47	**	**	80	**	**	5.5	**	**	19
GM-48	**	**	100	**	**	5.7	**	**	18
GM-49	**	**	170	**	**	6.0	**	**	19
GM-50	**	**	205	**	**	5.8	**	**	20
Landfill #1 & #4									
GM-28*	90	100	-	6.4	6.4	-	18	17	-
GM-29	190	210	-	5.9	5.7	-	17.5	13	-
GM-30*	490	370	-	6.5	6.9	-	18	17	-
GM-31	190	210	-	6.1	6.6	-	17.5	14	-
GM-32	235	460	-	5.9	5.7	-	18	14	-
GM-45*	**	**	625	**	**	6.8	**	**	20
GM-46	**	**	700	**	**	6.1	**	**	18
POL Area									
GM-33	60	50	-	6.3	5.7	-	17	17	-
GM-34	110	90	270	6.4	6.0	5.9	17	16	19.5
GM-35	160	150	-	6.5	6.4	-	17	15	-
GM-36	180	240	-	6.1	6.3	-	18	14	-
GM-44*	**	**	330	**	**	6.9	**	**	20
Flight Line Area									
GM-37	380	420	-	6.2	5.6	-	20	15	-
GM-38	385	420	-	5.6	5.9	-	19.5	17	-
GM-39	60	50	=	5.9	5.8	-	19	14	-
GM-40	260	90	-	5.5	5.6	-	20	15	-

*Monitor well installation into lower water table or artesian unit (30 foot depths); all other wells and well points are installed into the upper water table.
**Well not installed at time of sampling.
- Not sampled

RESULTS OF FIELD ANALYSES CONDUCTED ON GROUNDWATER

Well Number	Specific Conductivity (umhos/cm)			pH (standard units)			Temperature (°C)		
	Dec 82	Feb 83	Jun 83	Dec 82	Feb 83	Jun 83	Dec 82	Feb 83	Jun 83
Fire Training Areas #1 & #2									
GM-1	435	390	-	5.1	5.4	-	20	15	-
GM-2	158	225	-	5.1	4.9	-	20	16	-
GM-3	200	240	-	5.0	5.2	-	20	16	-
GM-4	485	520	-	5.8	6.3	-	20	14	-
GM-5	430	510	-	5.4	5.8	-	19.5	15	-
GM-6*	290	260	-	5.0	5.9	-	19.5	18	-
GM-7	300	290	-	5.5	5.1	-	19.5	16	-
GM-8	200	260	-	5.6	6.0	-	20	16	-
GM-9*	465	410	-	6.4	6.1	-	20	19	-
Landfill #3 Weathering Pit #2									
GM-10	800	800	-	5.8	6.2	-	19	16	-
GM-11	110	90	-	6.0	6.4	-	18	15	-
GM-12*	500	490	-	6.0	6.7	-	18	16	-
GM-13	120	135	-	5.7	5.8	-	18	15	-
GM-14	1050	800	850	6.2	6.2	6.2	19	14	19.5
GM-15	305	360	-	6.6	6.3	-	15	14	-
GM-16*	385	380	-	6.5	6.8	-	18	17	-
GM-17	430	600	950	5.6	6.5	6.2	18	14	24
GM-18	500	500	600	6.4	5.3	5.8	18	14	22
GM-41*	**	**	355	**	**	7.0	**	**	20
GM-51	**	**	80	**	**	5.9	**	**	20
GM-52	**	**	230	**	**	5.9	**	**	20
GM-53	**	**	625	**	**	5.0	**	**	20
GM-54	**	**	550	**	**	6.1	**	**	21.5
GM-55	**	**	750	**	**	6.2	**	**	21
GM-56	**	**	550	**	**	6.4	**	**	21.5
Fire Training Area #3									
GM-19	290	235	360	5.8	6.2	5.8	18	14	17
GM-20	500	350	-	6.1	6.6	-	17.5	16	-
GM-21	140	100	-	5.7	5.7	-	18	14	-
GM-22*	400	500	-	6.9	6.2	-	18	18	-
GM-42*	**	**	420	**	**	6.8	**	**	18.5

APPENDIX F

RESULTS OF FIELD ANALYSES CONDUCTED ON GROUNDWATER SAMPLES COLLECTED AT MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

GENERAL CONSTRUCTION AND
SURVEYING DATA FOR MONITOR WELLS AND WELL POINTS

Well Number	Well Depth (Ft)	Screened Interval (Ft)	Elevation at Top of Outer Casing (Ft Above MSL)
Fire Training Areas #1 & #2			
GM-1	12.5	2.5 - 12.5	26.38
GM-2	13.0	3.0 - 13.0	26.18
GM-3	12.5	2.5 - 12.5	26.21
GM-4	13.5	3.5 - 13.5	25.99
GM-5	12.5	2.5 - 12.5	25.22
GM-6	30.0	20.0 - 30.0	24.86
GM-7	12.5	2.5 - 12.5	25.15
GM-8	13.0	3.0 - 13.0	27.00
GM-9	30.0	20.0 - 30.0	27.13
Landfill #3 Weathering Pit #2			
GM-10	14.0	4.0 - 14.0	19.84
GM-11	13.0	3.0 - 13.0	20.75
GM-12	30.0	20.0 - 30.0	21.41
GM-13	13.0	3.0 - 13.0	21.50
GM-14	11.5	1.5 - 11.5	15.89
GM-15	13.0	3.0 - 13.0	17.98
GM-16	30.0	20.0 - 30.0	17.93
GM-17	5.5*	0.5 - 5.5*	17.33
GM-18	5.5*	0.5 - 5.5*	15.50
GM-41	33.0	28.0 - 33.0	15.29
GM-51	5.0*	0.5 - 5.0*	15.34
GM-53	5.0*	0.5 - 5.0*	14.47
GM-53	5.0*	0.5 - 5.0*	13.77
GM-54	5.0*	0.5 - 5.0*	13.96
GM-55	5.0*	0.5 - 5.0*	13.96
GM-56	5.0*	0.5 - 5.0*	14.38
Fire Training Area #3			
GM-19	13.0	3.0 - 13.0	21.66
GM-20	14.0	4.0 - 14.0	21.84
GM-21	13.0	3.0 - 13.0	21.66
GM-22	30.0	20.0 - 30.0	21.48
GM-42	30.0	25.0 - 30.0	21.60

APPENDIX E

GENERAL CONSTRUCTION AND SURVEYING DATA FOR MONITOR WELLS AND WELL POINTS INSTALLED AT MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

TABLE I

RECOMMENDED LOCATIONS FOR BOREHOLES IN THE MBPC TANK FARM AREA

Location for Borehole	Conductivity Values
1. 250N, 250W (near culvert)	High
2. 50N, 300W	Low
or	
3. 250N, 400W	Low
4. 350S, 500E East of Building 519	High
5. 350S, 200E West of Building 519	Low
6. Baseline, 225E	High
7. 50N, 300E	Low
or	
8. 250N, 300E	Low

Recommendations

Based on the lack of conclusive data from the geologic logs and water table levels obtained in the twelve boreholes drilled in an area of 10^5 square feet, or 2 acres near the JP4 spill, we must recommend that a number of boreholes be drilled. A soils analysis should be carried out on the soil from each borehole. A good measure of the volume of JP4 fuel should also be obtained. A number of permeability measurements should also be obtained.

We recommend that the boreholes be located as shown in Table I. These boreholes only need to be drilled to a depth of 20 feet. The information from these boreholes will help us to use the conductivity measurements to map precisely the extent of the JP4 fuel spill in the area of the MBPC tank farm.

EarthTech, Inc. would be willing to help with the specific locations of the boreholes. EarthTech is also capable of carrying out the soils analysis, the permeability measurements, and the chemical analysis needed to determine the extent of the spilled JP4 fuel.

Summary and Conclusions

The conductivity maps obtained using the EM-31 conductivity meter show that there is an area of very high conductivity in the same area as the JP4 fuel spill occurred during May of 1982. The conductivity generally decreases as we approach the old railroad bed, but that there is an area of high conductivity going toward and beyond the culvert running under the old railroad bed at 275N, 250W. The conductivity remains high in a southeast direction from the valves where the spill occurred, running along the west side of the East Ditch. The conductivity remains high to beyond the south side of Avenue "D". It is unlikely but possible that all of this area could be contaminated from the fuel spill which occurred in May, 1982. The fuel could have traveled about 300 feet from the source since May if the permeability in the fine sand is around 10^{-3}cm/sec. There is a decrease in the conductivity just southeast of a small gulley at 50S, 250E, where fuel odor was detected. The distance from the valves to this decrease in conductivity is about 300 feet. It is interesting to note that the distance to the culvert at 275N, 250W is about 350 feet.

It is difficult to understand why the conductivities are so high compared to the average background levels of 20 millimhos per meter at the Myrtle Beach AFB. Clay soil in a sandy soil host material will show as an increase of ground conductivity. The borehole logs from the 12 boreholes drilled in the area do not give sufficient information to draw any definite conclusions regarding variations of soil type in the area. It is also difficult to understand why a clay lense should just happen to occur where the spill occurred, and further to understand why the clay area does not extend to the east side of the man-made ditch.

The electrical properties of the JP4 are not known to the author at this time. I would expect that the JP4 would be resistive but the additives could make the fuel conductive. It is obvious that more information is needed to determine the extend of the JP4 fuel in the soil around the valves at the MBPC tank farm.

A borehole to the west of Building 519 at 350S, 200E would be placed in a low conductivity area and a borehole to the east of the building at 350S, 500E would be placed at a conductivity high. A borehole to the east of the East Ditch at 250N, 300E would be placed in a conductivity low and another placed on the baseline, 225E would be at a conductivity high. This last borehole will be in the same general material as that of the spill area. More detailed geologic logs and geochemistry logs especially sensitive to the volume of JP4 are needed in the boreholes suggested here. Permeability measurements would also be useful to help predict the extent of the fuel in the soil. The boreholes do not need to be drilled deeper than 20 feet unless a variation of soil type is occurring. Obviously the greater the number of boreholes and tests carried out the better our analysis will be.

The EM-31 conductivity meter is sensitive to changes of electrical conductivity in the ground. The conductivity in the ground can vary depending on soil type, a variation in water table level, and a leachate plume in the groundwater.

It is possible that a clay lense exists just where the fuel spill occurred and only to the west side of a man-made ditch. The geologic logs do not give sufficient information nor do the boreholes extend far enough to give evidence one way or another. Topographically the area surveyed is relatively flat. The surface elevations vary by less than five feet over the whole area surveyed except in the East Ditch and the ditches by the old railroad bed. The soil is generally a fine sand and it is unlikely that the water table varies in elevation by more than a few feet. This was observed in the boreholes drilled in the area of the spill.

I do not know the electrical properties of the JP4 fuel. I expect the JP4 fuel to be very resistive, but the additives put into the fuel may be conductive, thus making the bulk electrical properties of the fuel conductive.

It is possible that 50,000 gallons of fuel could spread over an area of 300 feet by 300 feet at an average thickness of 0.1 feet in 90 days, if the soil permeability at the water table is 10^{-3}cm/sec. The permeability of fine sand is typically on the order of 10^{-3} cm/sec. Our measurements were carried out 200 days after the spill of more than 120,000 gallons of JP4. Thus it is possible that a thin film of fuel could have spread more than 300 feet since the spill occurred.

There is little or no difference of soil type between boreholes 5, 6, and 11. The water table was logged at a depth of 4 feet in borehole 5 and 11, and 1 foot in borehole 6. The conductivity was high at around boreholes 5 and 6 and significantly lower at borehole 11. No correlations between the electrical conductivities measured and the soil type or water table exist in this area. It would be useful to put in additional boreholes around the culvert at 250N, 250W where the high conductivities are observed. A number of boreholes should be placed where the conductivities decrease significantly. Possible locations for these boreholes might be at 50N, 300W, and, 250N, 400W where the conductivities are low on the east side of the east ditch.

The conductivity remains high to the southeast of the spill area running parallel to the East Ditch all the way to the southside of Avenue "D" to the east of 4th Street. The extent of the high conductivities beyond Avenue "D" was not surveyed. It is interesting to note that the area of high conductivities does not extend to the east side of the East Ditch except at the gully from the P.O.L. site where fuel odor was detected. The ditch is man made and thus there is no obvious geologic reason for a clay lense to exist only on one side of the ditch.

The borehole geologic logs from boreholes 7, 1, 8, 9, or 12 give no obvious reason for the high conductivities observed at boreholes 7, 1, and 8, and not at boreholes 9 and 12. Possibly there is slightly less clay content in the soil around boreholes 9 and 12, but the geologic logs are not sufficiently detailed. Fuel odor was also detected at the gully flowing from the MBPC tank farm into the East Ditch at 200S, 250E. There is a slight decrease in the conductivity values to the south of this gully and then the values increase again around the parking area of Building 519. It is possible that the high conductivity area around Building 519 may have a different origin from that of the fuel spill area at the grid origin. Further information is necessary to determine the cause of the high conductivity around and to the southeast of Building 519.

Part G-2: Landfill #3/Weathering Pit #2

12/82 Data Set: Samples Collected During
December 8, 9, and 10, 1982

02/83 Data Set: Samples Collected During
February 18 and 19, 1983

06/83 Data Set: Samples Collected During
June 7 and 8, 1983

Landfill #3/Weathering Pit #2: 12/82 Data Set

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
10	0.060	11.0	<0.050	43.3	ND	143.5	9.6	0.976	71.1	ND	0.378	0.106	ND	ND	0.013	ND	ND
11	0.017	3.1	<0.050	19.6	ND	15.8	0.8	0.033	15.8	NA	NA	NA	0.005	NA	ND	NA	ND
12	0.022	4.8	<0.050	ND	ND	36.3	1.0	0.306	23.5	NA	NA	NA	ND	NA	ND	NA	0.004
13	0.019	2.5	<0.050	11.2	ND	18.9	1.3	0.028	14.1	NA	NA	NA	ND	NA	ND	NA	0.006
14	0.022	28.0	<0.937	8.1	ND	114.0	7.8	0.564	0.1	0.002	0.315	0.016	ND	ND	0.007	ND	0.018
15	0.019	4.0	<0.050	4.9	ND	27.2	0.7	0.062	28.6	NA	NA	NA	0.002	NA	ND	NA	ND
16	0.016	2.3	<0.050	ND	ND	23.6	5.0	0.243	20.3	NA	NA	NA	ND	NA	ND	NA	0.006
17	0.076	11.0	<0.050	5.7	ND	117.4	3.2	0.092	62.3	ND	0.173	0.016	0.003	ND	ND	0.004	0.008
18	0.012	11.0	<0.050	62.1	ND	102.8	3.6	0.132	65.8	NA	NA	NA	ND	NA	ND	NA	ND

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides

TOC = Total Organic Carbon

Landfill #3/Weathering Pit #2: 02/83 Data Set

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
10	6.08	917	10.2	NA
11	5.73	102	1.9	NA
12	7.20	573	3.3	NA
13	4.79	162	2.4	NA
14	6.33	869	24.0	NA
15	6.36	408	4.4	NA
16	7.24	415	2.6	NA
17	5.87	623	19.6	Benzene 0.011 Chlorobenzene 0.005 Chloroform 0.002 1,2-Dichloroethane 0.013 Ethylbenzene 0.036 Toluene <0.002 1,2-trans-Dichloroethylene 0.002
18	5.77	606	12.9	NA

NA = Not Analyzed

TOC = Total Organic Carbon

Landfill #3/Weathering Pit #2: 06/83 Data Set

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
14	6.6	792.5	32.2	0.163	8.4	76.5	485.1	90.6	11.7	71.0	2.2	Benzene 0.003 Toluene 0.0005 Ethylbenzene 0.0004 Chloroform 0.0009 Chloroethane 0.0004 Methylene chloride 0.0007 1,2-Dichloroethane 0.0003 1,2-trans-Dichloroethylene 0.0003 Chlorobenzene 0.0004 1,1-Dichloroethane 0.0002
17	7.8	1022.9	7.5	*	1.9	207.4	225.8	70.8	15.4	115.8	1.7	Benzene ND Toluene 0.0002 Ethylbenzene ND Chloroform 0.0005 Chloroethane ND Methylene chloride T 1,2-Dichloroethane T 1,2-trans-Dichloroethylene T Chlorobenzene ND 1,1-Dichloroethane ND
18	6.3	703.4	12.7	0.091	16.9	153.8	402.7	57.3	11.5	85.9	3.7	Benzene 0.0002 Toluene 0.0003 Ethylbenzene ND Chloroform 0.0003 Chloroethane 0.0004 Methylene chloride 0.002 1,2-Dichloroethane 0.004 1,2-trans-Dichloroethylene 0.009 Chlorobenzene T 1,1-Dichloroethane 0.002

(continued)

NA = Not Analyzed.

ND = Not Detected.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

T = Trace.

Landfill #3/Weathering Pit #2: 06/83 Data Set (Cont.)

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
41	7.6	368.0	1.1	0.009	0.7	22.5	226.9	46.8	0.6	18.7	3.1	Benzene ND Toluene 0.0002 Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane ND
51	4.4	145.5	2.1	<0.005	10.8	6.5	46.4	4.0	1.8	0.13	0.29	Benzene ND Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane ND
52	6.7	270.1	3.1	0.009	4.2	21.1	230.4	28.4	3.8	21.0	2.5	Benzene ND Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane ND

(continued)

NA = Not Analyzed.

ND = Not Detected.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

T = Trace.

Landfill #3/Weathering Pit #2: 06/83 Data Set (Cont.)

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
53	6.2	699.1	15.0	0.114	1.6	98.6	543.5	69.3	1.01	72.0	2.40	Benzene 0.002 Toluene ND Ethylbenzene ND Chloroform ND Chloroethane 0.0005 Methylene chloride 0.0033 1,2-Dichloroethane 0.020 1,2-trans-Dichloroethylene 0.004 Chlorobenzene 0.0007 1,1-Dichloroethane 0.0009
54	6.8	517.9	8.1	0.042	30.8	49.7	295.0	59.6	4.9	52.8	1.50	Benzene ND Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane ND
55	6.8	700.7	12.4	0.056	1.5	80.1	468.6	85.1	13.8	59.8	2.86	Benzene 0.0002 Toluene ND Ethylbenzene 0.0004 Chloroform ND Chloroethane ND Methylene chloride 0.0003 1,2-Dichloroethane 0.002 1,2-trans-Dichloroethylene 0.0009 Chlorobenzene 0.0002 1,1-Dichloroethane T

NA = Not Analyzed.

ND = Not Detected.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

T = Trace.

(continued)

Landfill #3/Weathering Pit #2: 06/83 Data Set (Cont.)

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
56	6.8	744.3	5.6	0.059	36.5	126.3	328.9	61.8	13.6	84.9	3.2	Benzene ND Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane ND

NA = Not Analyzed.

ND = Not Detected.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

* = Sample bottle broken.

T = Trace.

Part G-3: Fire Training Area #3

12/82 Data Set: Samples Collected During
December 8, 9, and 10, 1982

02/83 Data Set: Samples Collected During
February 18 and 19, 1983

06/83 Data Set: Samples Collected During
June 7 and 8, 1983

Fire Training Area #3: 12/82 Data Set

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
19	0.058	27.0	0.785	6.1	ND	49.6	5.7	0.079	23.2	NA	NA	NA	ND	NA	ND	NA	ND
20	0.025	20.0	1.006	1.7	ND	56.3	24.2	0.235	47.0	NA	NA	NA	ND	NA	ND	NA	0.001
21	1.20	6.1	<0.050	26.4	ND	20.5	1.9	0.059	14.7	NA	NA	NA	0.005	NA	ND	NA	ND
22	0.022	3.1	<0.050	3.6	ND	17.0	0.7	0.258	16.5	NA	NA	NA	ND	NA	ND	NA	ND

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides

TOC = Total Organic Carbon

Fire Training Area #3: 02/83 Data Set

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
19	5.74	274	20.7	Benzene 0.710 Chlorobenzene 3.1 Chloroform 0.002 1,1-Dichloroethane 0.014 Ethylbenzene 0.960 Toluene 1.90
20	6.91	386	4.3	NA
21	5.32	132	5.5	Chlorobenzene 0.009 Chloroethane 0.010 1,1-Dichloroethane 0.020 1,2 trans-Dichloroethylene 0.300
22	6.37	556	18.9	NA

NA = Not Analyzed

TOC = Total Organic Carbon

Fire Training Area #3: 06/83 Data Set

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
19	6.4	309.3	26.8	0.209	NA	NA	NA	NA	NA	NA	NA	Benzene >0.065* Toluene >0.065* Ethylbenzene 0.003 Chloroform 0.001 Chloroethane ND Methylene chloride T 1,2-Dichloroethane 0.002 1,2-trans-Dichloroethylene 0.003 Chlorobenzene 0.400 1,1-Dichloroethane 0.129
42	7.6	422.6	--	0.026	NA	NA	NA	NA	NA	NA	NA	Benzene ND Toluene T Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane 0.0004

NA = Not Analyzed.

ND = Not Detected.

T = Trace.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

*Only ">" (greater than) values are available because of an error occurring during the analysis. An additional sample was not available for a repeat analysis.

Part G-4: Weathering Pit #1

12/82 Data Set: Samples Collected During December 8, 9, and 10, 1982

02/83 Data Set: Samples Collected During February 18 and 19, 1983

06/83 Data Set: Samples Collected During June 7 and 8, 1983

Weathering Pit #1: 12/82 Data Set

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
23	0.018	8.3	0.054	17.4	ND	20.2	1.9	0.045	13.7	NA	NA	NA	0.050	NA	ND	NA	ND
24	2.050	17.0	0.405	10.7	ND	29.1	5.8	0.069	21.2	NA	NA	NA	ND	NA	ND	NA	ND
25	0.099	6.2	<0.050	22.2	ND	14.9	3.3	0.024	12.8	NA	NA	NA	ND	NA	ND	NA	ND
26	0.047	8.6	0.056	4.6	ND	15.5	1.9	0.025	10.5	NA	NA	NA	ND	NA	0.007	NA	0.008
27	0.011	2.6	<0.050	ND	ND	19.6	1.6	0.114	17.3	NA	NA	NA	0.002	NA	ND	NA	ND

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides

TOC = Total Organic Carbon

Weathering Pit #1: 02/83 Data Set

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
23	5.45	134	7.6	NA
24	5.40	188	19.6	Benzene 1.010 Ethylbenzene 0.880 Toluene 0.990 1,2 trans-Dichloroethylene 6.400
25	5.63	171	4.9	NA
26	5.41	99	5.6	Benzene 0.260 Chlorobenzene 0.023 Ethylbenzene 0.380
27	7.39	444	2.7	NA

NA = Not Analyzed

TOC = Total Organic Carbon

Flight Line Area: 12/82 Data Set

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
37	0.050	15.0	<0.050	25.3	ND	18.2	3.9	0.115	41.6	NA	NA	NA	ND	NA	0.093	NA	0.004
38	0.117	38.0	<0.050	118.9	ND	8.8	4.2	0.024	29.8	NA	NA	NA	0.002	NA	ND	NA	ND
39	0.039	20.0	<0.050	12.8	ND	5.8	7.8	0.396	11.8	NA	NA	NA	0.117	NA	0.104	NA	0.150
40	0.038	18.0	<0.050	30.8	ND	8.3	7.2	0.243	10.8	NA	NA	NA	ND	NA	0.007	NA	ND

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides

TOC = Total Organic Carbon

Part G-7: Flight Line Area

12/82 Data Set: Samples Collected During December 8, 9, and 10, 1982

02/83 Data Set: Samples Collected During February 18 and 19, 1983

06/83 Data Set: Samples Collected During June 7 and 8, 1983

Landfills #1 and #4: 06/83 Data Set

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
45	7.8	372.6	9.3	0.034	2.9	12.1	250.3	62.6	2.0	9.3	1.1	Benzene 0.0006 Toluene 0.0006 Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane ND
46	6.9	827.8	21.5	0.045	162.5	17.1	379.2	133.1	3.4	0.4	15.4	Benzene ND Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene 0.0003 Chlorobenzene 0.0003 1,1-Dichloroethane ND

NA = Not Analyzed.

ND = Not Detected.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

Landfills #1 and #4: 02/83 Data Set (Cont.)

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
30	6.97	429	7.7	NA
31	6.60	256	19.7	NA
32	4.67	702	18.7	NA

NA = Not Analyzed

TOC = Total Organic Carbon

Landfills #1 and #4: 02/83 Data Set

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
28	6.04	116	1.5	NA
29	5.11	249	20.4	NA

NA = Not Analyzed

TOC = Total Organic Carbon

Landfills #1 and #4: 12/82 Data Set (Cont.)

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
30	0.040	9.0	<0.050	37.7	ND	49.9	4.5	0.148	50.9	NA	NA	NA	ND	NA	ND	NA	0.002
31	0.045	27.0	<0.050	20.9	ND	18.5	0.5	0.001	13.7	ND	0.018	0.008	ND	ND	ND	0.006	ND
32	0.089	22.0	<0.050	36.0	ND	46.0	0.1	0.014	40.1	ND	0.032	0.023	ND	ND	0.018	ND	0.003

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides

TOC = Total Organic Carbon

Landfills #1 and #4: 12/82 Data Set

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
28	0.006	4.1	<0.500	34.4	ND	14.4	2.7	0.033	7.9	NA	NA	NA	0.001	NA	ND	ND	ND
29	0.006	21.0	<0.050	25.9	ND	41.9	0.8	0.045	35.4	ND	0.060	0.021	0.031	ND	ND	ND	0.022

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides

TOC = Total Organic Carbon

Part G-6: Landfills #1 and #4

12/82 Data Set: Samples Collected During December 8, 9, and 10, 1982

02/83 Data Set: Samples Collected During February 18 and 19, 1983

06/83 Data Set: Samples Collected During June 7 and 8, 1983

POL Area: 06/83 Data Set

GM sample No	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
35	6.2	169.5	12.1	0.014	NA	NA	NA	NA	NA	NA	NA	Benzene 0.001 Toluene 0.005 Ethylbenzene 0.004 Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene ND Chlorobenzene ND 1,1-Dichloroethane ND
44	7.5	375.1	0.6	0.012	NA	NA	NA	NA	NA	NA	NA	Benzene ND Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene 0.0001 Chlorobenzene ND 1,1-Dichloroethane ND

NA = Not Analyzed.

ND = Not Detected.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

POL Area: 02/83 Data Set

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
33	4.50	131	3.2	NA
34	5.75	108	2.6	NA
35	5.97	129	10.7	Benzene 0.090 Ethylbenzene 0.460 Chlorobenzene 0.010
36	5.84	183	13.3	NA

NA = Not Analyzed

TOC = Total Organic Carbon

POL Area: 12/82 Data Set

GM Sample No.	TOX (mg/L)	TOC (mg/L)	Phenol (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Fe (mg/L)	Mn (mg/L)	Na (mg/L)	As (mg/L)	Ba (mg/L)	Cr (mg/L)	Pb (mg/L)	Hg (mg/L)	Zn (mg/L)	Se (mg/L)	V (mg/L)
33	0.012	4.8	<0.050	22.0	ND	12.3	0.9	0.042	NA	NA	NA	NA	ND	NA	0.099	NA	0.002
34	0.020	3.0	<0.050	18.7	ND	12.4	0.7	0.038	10.8	NA	NA	NA	0.005	NA	0.120	NA	ND
35	0.036	9.5	<0.050	6.8	ND	11.2	3.4	0.095	7.9	NA	NA	NA	0.003	NA	0.002	NA	ND
36	0.020	6.1	<0.050	12.6	ND	27.8	5.8	0.082	19.2	NA	NA	NA	ND	NA	0.002	NA	ND

NA = Not Analyzed

ND = Not Detected

TOX = Total Organic Halides

TOC = Total Organic Carbon

Part G-5: POL Area

12/82 Data Set: Samples Collected During
December 8, 9, and 10, 1982

02/83 Data Set: Samples Collected During
February 18 and 19, 1983

06/83 Data Set: Samples Collected During
June 7 and 8, 1983

Weathering Pit #1: 06/83 Data Set (Cont.)

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
48	5.6	111.3	4.3	*	NA	NA	NA	NA	NA	NA	NA	Benzene 0.016 Toluene T Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene 0.023 Chlorobenzene 0.004 1,1-Dichloroethane 0.0001
49	6.3	188.3	2.6	0.042	NA	NA	NA	NA	NA	NA	NA	Benzene ND Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene 0.0004 Chlorobenzene ND 1,1-Dichloroethane ND
50	6.1	238.7	2.2	<0.005	NA	NA	NA	NA	NA	NA	NA	Benzene 0.0002 Toluene ND Ethylbenzene ND Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene 0.0003 Chlorobenzene ND 1,1-Dichloroethane ND

NA = Not Analyzed.

ND = Not Detected.

T = Trace

* = Sample bottle broken

TOC = Total Organic Carbon

TOX = Total Organic Halides

Weathering Pit #1: 06/83 Data Set

GM sample No.	pH	Specific conductivity	TOC (mg/L)	TOX (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Bicarbonate (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Volatile organics (GC scan) (mg/L)
24	5.5	163.0	14.7	0.224	NA	NA	NA	NA	NA	NA	NA	Benzene >0.065 Toluene >0.065 Ethylbenzene 0.067 Chloroform ND Chloroethane ND Methylene chloride 0.001 1,2-Dichloroethane 0.003 1,2-trans-Dichloroethylene 0.0790 Chlorobenzene 0.017 1,1-Dichloroethane 0.007
43	7.6	345.0	1.1	0.124	NA	NA	NA	NA	NA	NA	NA	Benzene T Toluene 0.0001 Ethylbenzene ND Chloroform 0.0006 Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene 0.011 Chlorobenzene ND 1,1-Dichloroethane ND
47	5.7	91.3	44.5	0.056	NA	NA	NA	NA	NA	NA	NA	Benzene 0.013 Toluene 0.001 Ethylbenzene 0.016 Chloroform ND Chloroethane ND Methylene chloride ND 1,2-Dichloroethane ND 1,2-trans-Dichloroethylene 0.041 Chlorobenzene 0.008 1,1-Dichloroethane 0.0001

(continued)

NA = Not Analyzed.

ND = Not Detected.

TOC = Total Organic Carbon.

TOX = Total Organic Halides.

T = Trace.

Flight Line Area: 02/83 Data Set

GM Sample No.	pH	Specific conductivity	TOC (mg/L)	Volatile Organic Compounds (GC/MS) (mg/L)
37	6.33	486	27.0	NA
38	5.81	520	22.3	Chloroform 5 1,2-Dichloroethane 12
39	5.60	62	14.7	NA
40	5.24	125	35.0	NA

NA = Not Analyzed

TOC = Total Organic Carbon

APPENDIX H

WATER LEVEL DATA COLLECTED FROM MONITOR WELLS AND WELL POINTS AT MYRTLE BEACH AIR FORCE BASE, SOUTH CAROLINA

WATER LEVEL DATA FROM MONITOR WELLS AND WELL POINTS

Well Identification	December 7, 1982 Depth to Water Below Ground Surface (ft)	December 7, 1982 Elevation of Ground-Water (ft above msl)	February 14, 1983 Depth to Water Below Ground Surface (ft)	February 14, 1983 Elevation of Ground-Water (ft above msl)	June 6, 1983 Depth to Water Below Ground Surface (ft)	June 6, 1983 Elevation of Ground-Water (ft above msl)
Fire Training Areas #1 and #2						
GM-1	4.78	19.40	2.91	21.27	6.32	17.86
GM-2	6.55	19.41	2.54	21.44	6.01	17.97
GM-3	4.82	19.19	3.05	20.96	6.19	17.82
GM-4	5.51	18.98	3.59	20.90	6.77	17.72
GM-5	4.16	18.86	2.40	20.62	5.16	17.86
GM-6*	7.70	15.56	6.07	17.19	9.04	14.22
GM-7	3.30	19.85	1.52	21.63	5.12	18.03
GM-8	5.26	19.84	3.07	22.03	7.03	18.07
GM-9*	9.29	15.74	7.71	17.32	10.86	14.17
Landfill #3 and Weathering Pit #2						
GM-10	3.62	14.12	1.11	16.63	5.81	11.93
GM-11	4.75	14.40	2.74	16.41	6.86	12.29
GM-12*	4.99	14.12	3.75	15.36	6.88	12.23
GM-13	7.95	11.55	5.99	13.51	8.58	10.92
GM-14	4.33	9.56	2.77	11.12	3.66	10.23
GM-15	2.04	14.34	0.18	16.20	6.75	9.63
GM-16*	3.19	12.84	1.52	14.51	4.91	11.12
GM-17	2.30	12.83	1.46	13.67	2.93	12.20
GM-18	1.00	11.50	+0.16	12.66	1.53	10.97
GM-41*	**	**	**	**	1.94	11.22
GM-51	**	**	**	**	1.64	12.15
GM-52	**	**	**	**	1.71	10.92
GM-53	**	**	**	**	2.02	9.89
GM-54	**	**	**	**	1.16	9.83
GM-55	**	**	**	**	2.14	9.84
GM-56	**	**	**	**	1.13	9.70
Fire Training Area #3						
GM-19	3.50	16.36	0.01	19.85	7.48	12.43
GM-20	3.82	16.42	0.55	19.69	7.69	12.55
GM-21	2.94	16.52	+0.35	19.81	6.91	12.55
GM-22*	4.86	14.62	2.91	16.57	6.45	13.03
GM-42*	**	**	**	**	7.06	12.91

WATER LEVEL DATA FROM MONITOR WELLS AND WELL POINTS (Cont.)

Well Identification	December 7, 1982		February 14, 1983		June 6, 1983	
	Depth to Water Below Ground Surface (ft)	Elevation of Ground-Water (ft above msl)	Depth to Water Below Ground Surface (ft)	Elevation of Ground-Water (ft above msl)	Depth to Water Below Ground Surface (ft)	Elevation of Ground-Water (ft above msl)
Weathering Pit #1						
GM-23	2.70	19.52	0.91	21.31	5.30	16.92
GM-24	2.25	20.58	1.43	21.40	6.02	17.01
GM-25	2.80	19.65	0.85	21.60	5.16	17.19
GM-26	2.44	19.60	0.68	21.36	5.20	16.84
GM-27*	6.95	15.15	5.14	16.96	8.28	13.82
GM-43*	**	**	**	**	8.83	13.88
GM-47	**	**	**	**	5.55	16.79
GM-48	**	**	**	**	5.60	16.75
GM-49	**	**	**	**	3.01	16.53
GM-50	**	**	**	**	3.58	16.71
Landfills #1 and #4						
GM-28*	4.75	21.00	3.61	22.14	7.51	18.24
GM-29	0.92	24.90	0.51	25.30	3.45	22.37
GM-30*	6.69	24.14	4.90	25.93	8.32	22.51
GM-31	1.85	28.76	0.33	30.36	3.04	27.57
GM-32	3.11	26.16	2.12	27.15	4.37	24.90
GM-45*	**	**	**	**	8.50	17.53
GM-46	**	**	**	**	5.03	20.78
POL Area						
GM-33	2.90	19.69	0.54	22.04	4.82	17.72
GM-34	3.85	18.86	1.50	21.20	6.05	16.66
GM-35	3.69	18.03	1.27	21.05	4.85	16.87
GM-36	4.11	16.85	+0.20	21.16	5.55	15.41
GM-44*	**	**	**	**	7.53	13.96
Flight Line Area						
GM-37	8.75	17.07	7.11	18.71	NC	NC
GM-38	8.68	17.02	6.87	18.77	NC	NC
GM-39	5.74	19.31	2.70	22.35	NC	NC
GM-40	5.62	16.99	1.49	21.12	NC	NC

*-Well is approximately 30 feet deep and is screened into the lower water-table or shallow-artesian unit; all other wells and well points are screened into the upper water table.
**-Well installed after date of measurement.
NC-Not collected

APPENDIX I

REFERENCES USED IN PREPARING IRP - PHASE II REPORT

REFERENCES

Engineering Science, 1981. Installation Restoration Program (IRP), Phase I - Records Search for Hazardous Materials Disposal Sites: Engineering Science, Inc., Atlanta, Georgia.

EPA, 1980. Water Quality Criteria Documents; Availability: U.S. Environmental Protection Agency, Federal Register Vol. 45, No. 231, November 28, 1980, pp. 79318-79341.

EPA, 1977. Draft Environmental Impact Statement, Grand Strand Region, South Carolina: U.S. Environmental Protection Agency, pp. 2-21.

Glowacz, M.E., 1980. Economic and Environmental Impact of Land Disposal of Wastes On the Shallow Aquifers of the Lower Coastal Plain of South Carolina: South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Groundwater Protection Division, Columbia, S.C., 92 p.

Hardee, H. K. and McFadden, S.K., 1982. Inventory of Known Groundwater Contamination Cases and Generalized Delineation of Five Groundwater Recharge Areas in South Carolina: South Carolina Department of Health and Environmental Control, Groundwater Protection Division, Bureau of Water Supply and Special Programs, Columbia, S.C., 120 p.

Hem, J.D., 1970. Study and Interpretation of the Chemical Characteristics of Natural Water: U.S. Geological Survey Water-Supply Paper 1473, 363 p.

Krauskopt, K. B., 1967. Introduction to Geochemistry: New York, McGraw-Hill, 721 p.

Pelletier, M., 1983. Oral Communication Regarding Hydrogeology and Groundwater Use in the Myrtle Beach Area: South Carolina Department of Health and Environmental Control, Columbia, S.C.

REFERENCES (Cont.)

Scalf, M.R., et al, 1981. Manual of Groundwater Sampling Procedures: NWWA/EPA Series, Robert S. Kerr Environmental Research Laboratory, U.S. Environmental Protection Agency, Ada, Oklahoma, 93 p.

Soil & Material Engineers, 1982. Preliminary Groundwater Hydrology Assessment of the Myrtle Beach Pipeline Company Site, Myrtle Beach, South Carolina: Soil Material Engineers, Inc., Hydrology Division, Columbia, S.C.

Spigner, B.C., 1977. Report on the Groundwater Resources of Horry and Georgetown Counties, South Carolina: South Carolina Water Resources Commission, Geology-Hydrology Division, Columbia, S.C., 52 p.

U.S.G.S, 1937. Myrtle Beach 15-Minute Quadrangle, Horry County, South Carolina: U.S. Geological Survey, Reston, Virginia.

Zack, A.L., 1980. Geochemistry of Fluoride in the Black Creek Aquifer System of Horry and Georgetown Counties, South Carolina - and its Physiological Implications: U.S. Geological Survey Water-Supply Paper 2067, 40 p.

Zack, A.L., 1977. The Occurrence, Availability, and Chemical Quality of Groundwater, Grand Strand Area and Surrounding Parts of Horry and Georgetown Counties, South Carolina: South Carolina Water Resources Commission Report No. 8, Columbia, S.C., 100 p.

APPENDIX J

BIOGRAPHIES OF KEY PERSONNEL

WILLIAM F. GUTKNECHT

Education

B.S., Chemistry, University of Wisconsin, Milwaukee, Wisconsin, 1964.

Ph.D., Analytical Chemistry, Purdue University, Lafayette, Indiana, 1970.

Experience

1980 to Present. Research Triangle Institute, Supervisor, Chemical Analysis Section, Environmental Chemistry Department. Supervisor of eleven analytical chemists performing collection (sampling), recovery and analysis of source, ambient, aqueous and biological samples. Directing research and development of new analytical procedures, especially procedures for characterization (speciation) and quantification of inorganic species. Other areas of scientific interest and activity include trace organic analysis and quality control/quality assurance. Used numerous techniques for measurement of trace levels of elements and molecular species. Techniques used include atomic absorption spectrometry, colorimetric methods, photon-induced x-ray fluorescence, proton-induced x-ray emission, neutron activation analysis, and photoelectron spectrometry. In the area of speciation, used Auger microscopy to characterize particles in lungs and ESCA to characterize tellurium, selenium, and lead particles generated and collected in the laboratory. Developed a new procedure for speciation which utilizes a combination of catalysis and gas chromatography where the species of interest (usually an ion) selectively catalyzes an organic reaction and one of the reaction products is measured using a sensitive gas chromatograph. Methods for measurement of Fe^{+3}, Cu^{+}, and CN^{-} at the parts-per-billion level have been developed using this approach. Used gas chromatography and high performance liquid chromatography for analysis of environmental air samples for ambient hydrocarbons, isocyanates, and chlordane. Investigated the limitations of a variety of air sample collection devices including stability of compounds in these devices and percent recovery from them.

1978 to 1980. Research Triangle Institute, Research Triangle Park, N. C. Environmental Chemist. Prepared quality assurance plans for various analytical studies including environmental screening and pesticide analysis programs. Prepared inorganic and organic samples for quantitative or performance audits and has participated in qualitative or systems audits of various analytical laboratories.

1971 to 1978. Duke University, Assistant Professor, Department of Chemistry. Taught undergraduate courses in general chemistry and instrumental analysis. Taught graduate courses in electrochemistry,

trace-element analysis, introductory electronics, and programming and on-line application of micro- and minicomputers. Accomplishments in research carried out with graduate students under my direction include: (a) Development of computer-controlled and real-time, computer-optimized analytical systems; (b) Development (with R. L. Walter) of the Duke University, proton-induced, x-ray emission analysis system and utilization of this system for analysis of numerous biomedical and environmental samples; (c) Development of ion-selective electrode systems for the measurement of thiols, sulfite and bromide; and (d) Studies of certain trace metals in select physiological systems, e.g., chromium in human blood serum, aluminum in human brain tissue, and cadmium in human lungs.

1970 to 1971. Louisiana State University, New Orleans, Louisiana, Postdoctoral Research Associate with Professor G. G. Guilbault. Development of ion-selective electrodes for the measurement of phosphate; development of enzyme-based ion-selective electrodes for the measurement of select thiols.

1964 to 1970. Purdue University, Graduate Research with Professor S. P. Perone. Development of computer-controlled and real-time, computer-optimized electroanalytical systems.

1963 to 1964. University of Wisconsin, Senior Research with Professor L. W. Bahe. Development and construction of a calorimeter.

Professional Associations

Sigma Xi
Phi Lambda Upsilon
Alpha Chi Sigma
American Chemical Society

Chapters or Sections of Books Published:

Electronics Experiments 18-21, "Instrumental Analysis Manual," G. G. Guilbault and L. G. Hargis, Marcel Dekker, Inc., New York, 1970.

Articles Published in Professional Journals:

1. "Double Wave Behavior of Cobalt(II) in Thiocyanate Medium at Dropping and Stationary Mercury Electrodes," S. P. Perone and W. F. Gutknecht, Anal. Chem., 39, 892-895 (1967).

2. "Real-Time Computer Optimization of Stationary Electrode Polarographic Measurements" S. P. Perone, D. O. Jones, and W. F. Gutknecht, Anal. Chem., 41, 1154-1162 (1969).

3. "The Numberical Deconvolution of Overlapping Stationary Electrode Polargraphic Curves with an On-Line Digital Computer," W. F. Gutknecht and S. P. Perone, Anal. Chem., 42, 906-917 (1970).

4. "An Electrochemical System for Monitoring the Removal of Cyanide from Aqueous Systems with Immobilized Injectase," W. F. Gutknecht and G. G. Guilbault, <u>Environmental Letters</u>, <u>2</u>(2), 51-57 (1971).

5. "Measurements of Injectase Activity using Sulfide Ion-Selective Electrode," W. F. Gutknecht, S. S. Kuan, R. Cochran, and G. G. Guilbault, <u>Anal. Biochem.</u>, <u>46</u>, 200-208 (1972).

6. "Analysis of Biological, Clinical and Environmental Samples Using Proton-Induced X-Ray Emission," R. L. Walter, R. D. Willis, W. F. Gutknecht, and J. M. Joyce, <u>Anal. Chem.</u>, <u>46</u>, 843-854 (1974).

7. "A New Method for Preparing Standard Targets for X-Ray Analysis," W. F. Gutknecht, R. Baum, R. L. Walter, and R. D. Willis, <u>Anal. Chem.</u>, <u>47</u>, 1727-1728 (1975).

8. "Direct Potentiometric Measurement of Several Thiols," Paul K. C. Tseng, and W. F. Gutknecht, <u>Anal. Chem.</u>, <u>47</u>, 2316-2319 (1975).

9. "Proton-Induced X-Ray Emission Analysis - A Valuable Technique Applied to Trace Metal Investigations of Soils and Metal Uptake in Plants," J. A. Stanford, R. D. Willis, R. L. Walter, W. F. Gutknecht, and J. Antonovics, <u>Radiation and Environmental Biophysics</u>, <u>12</u>, 175-180 (1975).

10. "Trace Element Studies in Bioenvironmental Samples Using 3-MeV Protons," R. L. Walter, R. D. Willis, and W. F. Gutknecht, in "Application of Small Accelerators," J. L. Duggan, Ed., 1975, p. 189.

11. "On-Line, Computer-Controlled Potentiometric Analysis System," John M. Ariano and W. F. Gutknecht, <u>Anal. Chem.</u>, <u>48</u>, 281-287 (1976).

12. "Levels of Toxic Metals in Marine Organisms Collected from Southern California Coastal Waters," B. Fowler, R. C. Fay, R. L. Walter, R. D. Willis, and W. F. Gutknecht, <u>Environmental Health Perspectives</u>, <u>12</u>, 71-76, (1975).

13. "The HgS/Hg_2Br_2-Based Bromide Ion-Selective Electrode," Paul K. C. Tseng and W. F. Gutknecht, <u>Analyt. Lett.</u>, <u>9</u>, 795-805 (1976).

14. "Proton-Induced X-Ray Emission Analysis for Metals Extractable from Soils with Buffer Solutions," R. Baum, W. F. Gutknecht, R. D. Willis, and R. L. Walter, <u>Analyt. Chim. Acta</u>, <u>85</u>, 323-329 (1976).

15. "Direct Potentiometric Measurement of Sulfite Ion with Mercuric Sulfide/Mercurous Chloride Membrane Electrode," Paul K. C. Tseng and W. F. Gutknecht, <u>Anal. Chem.</u> <u>48</u>, 1996-1998 (1976).

16. "Solution-Deposited Standards Using a Capillary Matrix and Lyophilization," R. M. Baum, R. L. Walter, W. F. Gutknecht, and A. R. Stiles, in X-Ray Fluorescence Analysis of Environmental Samples, T. Szubay, Ed., Ann Arbor Press, 1977, pp. 165-173.

17. "Application of Proton-Induced X-Ray Emission to Bioenvironmental Analysis," R. L. Walter, R. D. Willis, W. F. Gutknecht and R. S. Shaw, <u>Nucl. Instru. and Meth.</u>, <u>142</u>, 181-197 (1977).

Articles Published in Professional Journals: Continued.

18. "Proton-Induced X-Ray Emission Analysis of Thick and Thin Targets," R. D. Willis, R. L. Walter, and R. W. Shaw and W. F. Gutknecht, Nucl. Instr. and Meth., 142, 67-77 (1977).

19. "Investigations of Black Bronchoalveolar Human Lavage Fluid," W. S. Lynn, J. A. Kylstra, S. Sahu, J. Tainer, J. Shelburne, P. C. Pratt, W. F. Gutknecht, R. Shaw and P. Ingram, Chest, 72(4), 483-488 (1977).

20. "Gas Chromatography and Catalysis Applied to Trace Metal Speciation. Determination of Cuprous Ion," M. Ditzler and W. F. Gutknecht, Analytical Letters, All 8, 611-618 (1978).

21. "Autoxidation versus Covalent Binding of Quinones as the Mechanism of Toxicity of Dopamine, 6-Hydroxydopamine, and Related Compounds Toward C1300 Neuroblastoma Cells in Vitro", D. G. Graham, S. M. Tiffany, W. R. Bell, Jr., and W. F. Gutknecht, Molecular Pharmacology, 14, 644-653 (1978).

22. "Reexamination of Potentiometric Studies of the Oxidation of o-Tolidine," M. A. Ditzler, and W. F. Gutknecht, Anal. Chem., 50, 1883-1886 (1978).

23. "Performance Audit of Level 1 Environmental Assessment Analytical Systems," W. F. Gutknecht, Process Measurements Review (EPA), 2 (1), 9 (1979).

24. "Respirable Silicon-Positive Particles in Cigarette Smoke," J. D. Shelburne, W. F. Gutknecht, D. R. Wilder, P. Ingram, and H. K. Hawkins, Federation Proceedings 38, 1155 (1979).

25. "Identification and Therapeutic Removal of Foreign Substances in Phagocytic Cells from Human Airways, W. S. Lynn, J. A. Kylstra, S. Sahu, J. Tainer, J. D. Shelburne, P. C. Pratt, W. F. Gutknecht, R. Shaw, P. Ingram, and D. Wilder, INSERM 84, 345-352 (1979).

26. "Determination of Trace Levels of Iron(III) by Homogeneous Catalysis and Gas Chromatography," Mauri A. Ditzler, and W. F. Gutknecht, Anal. Chem., 52, 614-617 (1980).

27. "Cell-Particle Interactions: Intracellular Redistribution of Heavy Metals from Particle Surfaces," C. R. DeVries, P. Ingram, W. F. Gutknecht, S. R. Walker, R. W. Linton, and J. D. Shelburne, Lab. Invest. 42, 111-112 (1980).

28. "Level 1 Infrared and Low Resolution Mass Spectrometry," W. F. Gutknecht and Alvia Gaskill, Process Measurements Review (EPA), 2 (4), 2-3 (1980).

29. "Respirable Inorganic Particulates in Cigarette Smoke," J. P. Mastin, W. J. Furbish, W. F. Gutknecht, P. Ingram, J. D. Shelburne, Proceedings of the Clay Minerals Society, October 5-9, 1980.

30. "A Study of the Liquid-Liquid Partitioning Process Using Reverse-Phase Liquid Chromatography," C. H. Lochmuller, D. R. Wilder, and W. F. Gutknecht, Jr. Chem. Ed., 57, 381-382 (1980).

31. "Development of a Method for Sampling and Analysis of Metal Fumes," W. F. Gutknecht, M. B. Ranade, P. M. Grohse, A. S. Damle, and P. M. Eller, in ACS Symposium Series, No. 149, Chemical Hazards in the Workplace-Measurement and Control, G. Choudhary, ed., American Chemical Society, 1981, pp. 95-107.

32. "Determination of Cyanide Ion by Homogeneous Catalysis and Gas Chromatography," M. A. Ditzler, F. L. Keohan, and W. F. Gutknecht, Analytica Chimica Acta, 135, 69-75 (1982).

33. "Acute Toxicity of Lead Particulates on Pulmonary Alveolar Macrophages," C. R. DeVries, P. Ingram, S. R. Walker, R. W. Linton, W. F. Gutknecht, and J. D. Shelburne, Laboratory Investigation, 48 (1), pp. 35-44 (1983).

34. "Quality Assurance for Emission Analysis Systems," R. K. M. Jayanty, Corette B. Parker, Clifford E. Decker, and William F. Gutknecht, Environmental Science and Technology, 17 (6), pp. 257A-263A (1983).

35. "Evaluation of Selected Gaseous Halocarbons for Use in Source Test Performance Audits," G. B. Howe, R. K. M. Jayanty, A. V. Rao, W. F. Gutknecht, and C. E. Decker, Journal of the Air Pollution Control Association, 33(9):823-832, 1983.

36. "Evaluation of Selected Gaseous Halocarbons for Use in Source Test Performance Audits," G. B. Howe, R. K. M. Jayanty, W. F. Gutknecht and C. E. Decker, In: Proceedings of Measurement and Monitoring of Non-Criteria (Toxic) Contaminants in Air Specialty Conference, Air Pollution Control Association, Chicago, Illinois, 1983. pp. 258-267.

37. "Mercury Atmosphere Generation and Media Collection Efficiency Evaluations for the SASS Impingers," A. D. Shendrikar, Ashok Damle, W. F. Gutknecht, and Frank Briden, In: Proceedings of Measurement and Monitoring of Non-Criteria (Toxic) Contaminants in Air Specialty Conference, Air Pollution Control Association, Chicago, Illinois, 1983, pp. 386-403.

10/83

ook Reviews Published:

. Review of a text by H. F. Walton and J. Reyes, "Modern Chemical Analysis and Instrumentations," Anal. Chem., 46(3), 335A (1974).

. Review of a text by Galen W. Ewing, "Instrumental Methods of Chemical Analysis," Anal. Chem., 47(13), 1179A (1975).

. Review of a text by H. Willard, L. Merritt, J. Dean and F. Settle, "Instrumental Methods of Analysis. 6th Edition," Anal. Chem. 54(2), 353A (1982).

nvited Seminars Presented:

. "The Inorganic Analysis of Human Alveolar Macrophage," Department of Medicine, Duke University Medical School, October, 1975.

. "The Analysis of Human Lungs and Lung-Related Samples using PIXE, Electron Microprobe Analysis and Auger Spectrometry," University of North Carolina at Charlotte, March 1976.

. "The Analysis of Human Lungs and Lung-Related Samples using PIXE, Electron Microprobe Analysis, and Auger Spectrometry," University of North Carolina at Chapel Hill, March 1976.

. "The Study of Human Lungs Using Proton-Induced X-ray Emission Analysis, Electron Microscopy, and Photoelectron Spectrometry," Virginia Military Institute, Lexington, Virginia, February 1977.

. "Practical and Theoretical Consideration of the Mercuric Sulfide-Based Ion-Selective Electrode System," 1977 Fisher Award Symposium, 173rd National Meeting of the American Chemical Society, New Orleans, March 1977.

. "Practical and Theoretical Considerations of Mercuric Sulfide-Based Ion-Selective Electrodes," 1977 Eastern Analytical Symposium, New York, December 1977.

. "Ion-Selective Electrodes," 9th Annual MidWinter Conference on Current Chemistry Techniques Virginia Polytechnic Institute, Blacksburg, Virginia, February 1978.

. "Quality Assurance - A Way to Acceptable Analytical Data," Symposium on Industrial Problem Solving - A Multi-Technique Approach, 179th National Meeting of the American Chemical Society, Houston, Texas, March, 1980.

. "Quality Control in the Analytical Laboratory," Virginia Military Institute, Lexington, Virginia, July, 1980.

). "Quality Control in the Analytical Laboratory," Duke University, Durham North Carolina, July 1980.

.. "Systems and Performance Audits as Means of Laboratory Evaluation", 7th National Meeting of the Federation of Analytical Chemistry and Spectroscopy Societies, Philadelphia, Pennsylvania, September, 1980.

'. "Laboratory and Field Evaluation of Personal Sampling Badges and Charcoal Tubes," EPA National Symposium on Monitoring Hazardous Organic Pollutants in Air, Raleigh, North Carolina, April, 1981.

1977 - Summarized the hydrogeology and status of ground-
1978 water development in northern New Jersey as part of an evaluation of water-supply management alternatives available to the State.

1978 - Principal author and project manager of a three-year
1979 study to evaluate the effects of underground coal mining on ground-water availability and ground-water quality from underground coal mines in the eastern states.

1980 - Planned and managed a year-long investigation of a case of organic chemical contamination in Texas. Evaluated and implemented controls to minimize movement of contaminants.

1981 - Managed the development of a 20 mgd emergency ground-water supply for the City of Virginia Beach. Developed a mitigation program to minimize adverse effects of high yield wells on existing private wells in southeastern Virginia.

Publications and Presentations

Sgambat, J. P., and C. A. Rich, 1977. Hydrogeology and Waste-Water Management on Long Island, N.Y. Presented at the National Water Well Exposition, Boston, Massachusetts, September 9-15.

Sgambat, J. P., 1977. Water and Waste-Water Management on Long Island, N. Y. Presented at the American Water Resources Association's Thirteenth American Water Resources Conference, Tucson, Arizona, October 31-November 3.

Braids, O. C., D. W. Miller, and J. P. Sgambat, 1977. Contamination of Ground Water by Organic Chemicals. Presented at the Association of Official Analytical Chemists' Symposium on Environmental Contamination by Industrial Organic Chemicals, Washington, D.C., October 20.

Parizek, Richard, and J. P. Sgambat, 1978. Background Report for Premining Planning: Eastern Surface Coal Mining. In review by the Industrial Environmental Research Lab, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA Grant No. R803882-01-0.

JEFFREY P. SGAMBAT

Associate

Geraghty & Miller, Inc.

Professional Qualifications

Jeffrey P. Sgambat is an Associate and senior scientist with the firm of Geraghty & Miller, Inc. He holds a B.A. degree in geology from Lehigh University and an M.S. degree, with a concentration in hydrogeology, from Pennsylvania State University. Mr. Sgambat oversees the operations of the firm's Annapolis, Maryland office.

Mr. Sgambat has planned and implemented numerous exploratory test drilling programs, including design and installation of production wells, pumping tests, and aquifer evaluations. He has supervised a number of ground-water contamination studies, as well as investigations of proposed solid-waste and hazardous-waste disposal sites. Mr. Sgambat has contributed to water and waste-water management studies in several eastern states, and has also conducted research on the ground-water effects from surface and underground coal mining. In recent years, he has served as project advisor of numerous industrial projects and has also acted as program manager of several EPA studies providing technical support to the Agency on a variety of regulatory issues.

Geraghty & Miller, Inc., Work Experience

1974 - Evaluated ground-water contamination from mine tailings ponds at a site in Green River, Wyoming, and supervised a program of abatement involving the use of a one-mile long interceptor trench and a system of pump-back wells.

1975 - Provided hydrogeological field services during the drilling and testing of industrial water wells at Hannibal, Missouri. Conducted a detailed study of the infiltration effects from the Mississippi River, and the iron geochemistry of the aquifer system.

1976 - 1978 Participated in a two-year study of ground-water conditions on Long Island during the development of a 208 Areawide Waste Water Management Plan on behalf of the Nassau-Suffolk Regional Planning Board. Principal author of two reports to the Board entitled "Water Supply Philosophies and 208 Planning" and "Ground-Water Quality in Nassau and Suffolk Counties."

Selected Publications

A. Gaskill, Jr. and P. M. Grohse, "Ion Exchange Determination of Natural Water Organic Metal Complexing Capacities," presented at the American Chemical Society Meeting-in-Miniature at Duke University, Durham, North Carolina, April 17, 1981.

P. M. Grohse and W. F. Gutknecht, "Electrothermal Atomization, Atomic Absorption Measurement of Organotin Species Using the Graphite Platform", presented at the American Chemical Society, National Meeting in New York City, New York, September 27, 1981.

P. M. Grohse, W. F. Gutknecht, A. Gaskill, and C. R. Tronzo, "Analysis of Trace Quantities of Silicon by Electrothermal Atomic Absorption Using the Graphite Platform" presented at the 8th Annual FACSS Conference in Philadelphia, Pennsylvania, October 19, 1981.

1/82

Selected Publications

R. B. Denyszyn, L. T. Hackworth, P. M. Grohse, and D. E. Wagoner, "Hydrocarbon and Halocarbon Measurements: How Good are State-of-the-Art Measurements?" Presented at the International Conference on Photochemical Oxidant Pollution and Its Control, Raleigh, N.C., September 12-17, 1976.

S. K. Gangwal, R. B. Denyszyn, P. M. Grohse, and D. E. Wagoner, "Analysis of a Semi-Batch Coal Gasifier Product Gas Using an Automated Gas Chromatograph", Journal of Chromatographic Science, 16, 368-371, (1978).

S. K. Gangwal, P. M. Grohse, and D. E. Wagoner, "Measurement Methodology for Low Molecular Weight Sulfur Effluents from a Semi-Batch Coal Gasifier", presented at the 22nd Conference on Analytical Chemistry in Energy Technology, Oak Ridge National Laboratory, Gatlinburg, Tennessee, October 10-12, 1978.

R. B. Denyszyn, P. M. Grohse, and D. E. Wagoner, "Sampling and Atomic Absorption Spectrometric Determination of Arsine at the 2 g/m^3 Level", Anal. Chem., 50:8, 1094-1096 (1978).

P. M. Grohse, S. K. Gangwal, and D. E. Wagoner, "The Fate of Trace Metals in a Semi-Batch Coal Gasification Unit", presented at the 30th Pittsburgh Conference, Cleveland, Ohio, March 5-9 (1979)

S. K. Gangwal, D. G. Nichols, R. K. M. Jayanty, D. E. Wagoner, and P. M. Grohse, "A Sampling and Analysis Procedure for Gaseous Sulfur Compounds from Fossil Fuel Conversion", presented at the Oil Shale Sampling Analysis and Quality Assurance Symposium, Denver, Colorado, March 26 (1979).

S. K. Gangwal, P. M. Grohse, D. E. Wagoner and E. D. Estes, "Measurement Methods for Solid, Liquid, and Gaseous Pollutants from a Laboratory Coal Gasifier", I. Sampling Methods, GC and AA Procedures, submitted to the 31st Southeastern Regional ACS Meeting, Roanoke, October (1979).

P. M. Grohse, M. B. Ranade, and W. F. Gutknecht, "Development of a Method for Sampling and Analysis of Metal Fumes", presented at the American Chemical Society Meeting-in-Minature, Duke University, Durham, North Carolina, April 17, 1981.

W. F. Gutknecht, M. B. Ranade, P. M. Grohse, A. S. Damle, and P. M. Eller, "Development of a Method for Sampling and Analysis of Metal Fumes". Published in Chemical Hazards in the Workplace, G. Choudhary, Editor, P. 95-108.

PETER M. GROHSE

Education

B.S., Chemistry, University of Alabama in Huntsville, Huntsville, Alabama, 1969

Experience

July 1975 to date. Research Triangle Institute. Chemist. Analysis of trace hydrocarbons, halocarbons and heterocyclics by use of gas chromatographic techniques coupled with data acquisition system. Development of an atomic absorption technique for the analysis of trace arsine gas. Development of GC analytical methodology for coal gasification product gases. Development of analytical methodology for trace elements in environmental assessment samples. Development of sampling and analytical methodology for gaseous trace elements resulting from fuel conversion processes. Development of methodology for speciation of gaseous As, Se and Hg from fuel conversion processes. Experienced with source measurement techniques and associated quality assurance guidelines. Development of analytical methodology for the determination of Pb, Se, Te and Pt in industrial hygiene samples. Development of speciation and quantitation techniques for organo metallics utilizing GC-AA interface techniques.

May 1972 to July 1974. University of Alabama in Huntsville. Research Analyst. Water analysis using atomic absorption and colorimetric techniques. Ambient air monitoring using continuous NO_x, O_3, total sulfur monitors and continuous GC of HC's, CO.

February 1972 to May 1972. University of Alabama in Huntsville. Graduate Research Assistant. Worked with high vacuum systems and proportional counters used in outer atmospheric cosmic ray studies.

June 1970 to October 1971. U. S. Army. Light Weapons Infantry. Honorable Discharge.

September 1969 to June 1970. University of Alabama (Tuscaloosa). Graduate Teaching Assistant.

September 1968 to August 1969. University of Alabama in Huntsville. Undergraduate Laboratory Assistant. Synthesis of heterocyclic organic compounds and study of carbonium ions involved in formation of these systems.

Professional Societies

American Chemical Society, Analytical Chemistry Division

L. G. Purnell, E. D. Estes, and D. J. Hodgson, "The Interaction of Metal Ions with 8-Azapurines. II. Synthesis and Structure of bis-(8-azahypoxanthinato)tetraaquocadmium (II)", J. Am. Chem. Soc., 98, 740 (1976).

E. D. Estes and D. J. Hodgson, "Molecular Structure of Dichloro-(N,N,N'N'-tetraethylethylenediamine)copper(II)", J. Chem. Soc., Dalton Trans., 12, 1168 (1975).

E. D. Estes, W. E. Estes, R. P. Scaringe, W. E. Hatfield, and D. J. Hodgson, "Magnetic Properties of Tetraaquobis(-hippurato-O-bis-(hippurato-O) dicopper(II) Tetrahydrate", Inorg. Chem. 14, 2564 (1975).

R. A. Bream, E. D. Estes, and D. J. Hodgson, "The Structural Characterization of Dichloro[2-(2-methylaminoethyl)pyridine] copper(II)", Inorg. Chem. 14, 1672 (1975).

D. L. Lewis, E. D. Estes, and D. J. Hodgson, "The Infrared Spectra of Coordinated Perchlorates", J. Cryst. Mol. Struct., 5, 67 (1975).

E. D. Estes and D. J. Hodgson, "Copper (II) Complexes of Aminoalcohols. Molecular Structures of Chloro(2-diethylaminoethanolato)copper (II) and Bromo(2-dibutylaminoethanolato)copper(II)", Inorg. Chem. 14, 334 (1975).

E. D. Estes, W. E. Estes, W. E. Hatfield, and D. J. Hodgson, "Molecular Structure of Bis[dichloro(N,N,N',N'-tetramethylethylenediamine)copper (II)]", Inorg. Chem. 14, 106 (1975).

E. D. Estes, W. E. Hatfield, and D. J. Hodgson, "Structural Characterization of Di-α-hydroxo-bis(N,N,N',N'-tetramethylethylenediamine)-dicopper(II) perchlorate", Inorg. Chem. 13, 1654 (1974).

E. D. Estes and D. J. Hodgson, "Structural Characterization of Tetramethylammonium Pentakis(trichlorogermanyl)platinate(II)", Inorg. Chem. 12, (1973).

N. T. Watkins, E. E. Dixon, V. H. Crawford, K. T. McGregor, and W. E. Hatfield, "Chloro-bridged Triplet Ground-state Copper(II) Dimer", J. C Soc. Chem. Comm., 133 (1973).

2/82

Selected Publications

A. Gaskill, Jr., C. M. Sparacino, E. D. Estes, A. R. Turner, J. D. Albert, S. E. Frazier and C. A. Homzak, "Evaluation of HPLC and IC Methods for Measurement of Organic Acids in FGD Wastes," presented at the American Chemical Society Meeting in Miniature at Duke University, Durham, N.C., April 17, 1981.

R. A. Zweidinger, E. D. Estes and L. W. Little, "Analysis of Monosodium Methanearsonate (MSMA) in Raw and Biologically Treated Combined Industrial Municipal Wastewater" presented at the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, March 10-14, 1980, Atlantic City, New Jersey.

S. K. Gangwal, P. M. Grohse, D. E. Wagoner, and E. D. Estes, "Measurement Methods for Solid, Liquid and Gaseous Pollutants from a Laboratory Coal Gasifier. I. Sampling Techniques, GC and AA Procedures", presented at the 31st Annual Southeastern Regional Meeting of the American Chemical Society, Roanoke, Virginia, October 24-26, 1979.

F. Smith, E. D. Estes and D. E. Wagoner, "Field Evaluation of the SASS Train and Level 1 Procedures", Proceedings of the Process Measurements for Environmental Assessment Symposium, Atlanta, Georgia, February 13-15, 1978.

J. D. Mulik, E. Estes, and E. Sawicki, "Ion Chromatographic Analysis of NH_4^+ in Ambient Aerosols." Ion Chromatographic Analysis of Environmental Pollutants, E. Sawicki, J. D. Mulik and E. Wittgenstein, editors, Ann Arbor Science, 1978.

J. D. Mulik, G. Todd, E. Estes, and E. Sawicki, "Ion Chromatographic Determination of Atmospheric Sulfur Dioxide." Ion Chromatographic Analysis of Environmental Pollutants, E. Sawicki, J. D. Mulik and E. Wittgenstein, editors, Ann Arbor Science, 1978.

J. W. Hall, W. E. Estes, E. D. Estes, R. P. Scaringe and W. F. Hatfield, "Magnetic Susceptibility of the Chloro(2-diethylaminoethanolato)copper(II) Tetramer," Inorg. Chem. 16, 1512 (1977).

E. D. Estes, R. P. Scaringe, W. E. Hatfield, and D. J. Hodgson, "Structural and Magnetic Characterization of the Alkoxo-Bridged Chromium (III) Dimers, Di- -methoxy-bis[bis(3-bromo-2,4-pentanedionato)chromium(III)] and Di- -ethoxy-bis[bis(3-bromo-2,4-pentanedionato)chromium(III)], Inorg. Chem. 7, 1605 (1977).

E. D. Estes and D. J. Hodgson, "The Structural Characterization of Bis[dichloroaquopyridine-N-oxide copper (II)]", Inorg. Chem. 15, 348 (1976).

EVA D. ESTES

Education

B.S., Science Teaching, University of North Carolina at Chapel Hill, 1971

Ph.D., Chemistry, University of North Carolina at Chapel Hill, 1975

Experience

1977 to date. Research Triangle Institute. Environmental Chemist. Acid precipitation analysis and research. Quality assurance for precipitation analysis. Preparation and verfication of simulated precipitation samples. Air and water pollution research. Coordination of sampling and analytical work for environmental assessment studies. Verification of equipment and analytical schemes used for such studies. Evaluation of techniques proposed for the reduction of polychlorinated biphenyls. Determination of metals in the environment. Collection and distribution of atmospheric samples for analysis and correlation of the data obtained. Set up and operation of Dionex Model 14 Ion Chromatograph for analysis of water and air samples. Comparison of Federal Reference Method 6 to continuous analyzers for analysis of sulfur dioxide analysis of hivol filter samples for sulfate and nitrate by ion chromatography.

1976 to 1977. U.S. Environmental Protection Agency. Chemist. Development of the Dionex Model 10 Ion Chromatograph as an analytical method for determination of ammonium ion concentrations in the ambient atmosphere. Development of a new method for the determination of sulfur dioxide utilizing ion chromatography.

1975 to 1976. U.S. Army Research Office. Chemist. Screening of potential grant applications, review of research proposals, participation in funding decisions, and administration of grants. Development and preparation of documentation of the Army's chemistry research program for presentation to higher headquarters within the Department of Defense.

1975. University of North Carolina at Chapel Hill. Research Associate. Research in the correlation of structural features and magnetic properties of some chromium (III) dimers.

1971 to 1974. University of North Carolina at Chapel Hill. Teaching assistant and research assistant. Structural chemistry of magnetically condensed copper (II) systems.

Professional and Honorary Associations

American Chemical Society, Division of Environmental Chemistry
American Crystallographic Association
Phi Beta Kappa

Jayanty, R. K. M., and Gaskill, A., Jr., "Use of Reference Materials in a Comprehensive Quality Assurance Program,". Presented by Jayanty at the American Chemical Society Meeting in Miniature at Duke University, Durham, North Carolina, April, 1981.

Jayanty, R. K. M., and Blackard, A., "Determination of the Nonmethane Organic Carbon (NMOC) by Cryogenic Preconcentration and Flame Ionization Detection". Poster presentation at the American Chemical Society Meeting in Miniature at Duke University, Durham, North Carolina, April 1981.

Gutknecht, W. F., Decker, C. E., Howe, G. B., and Jayanty, R. K. M., "Laboratory and Field Evaluation of Personnel Sampling Badges and Charcoal Tubes". Presentation at the National Symposium on Monitoring Hazardous Organic Pollutants in Air, Raleigh, North Carolina, April 28 - May 1, 1981.

Howe, G. B., R. K. M. Jayanty, A. V. Rao, W. F. Gutknecht, and C. E. Decker. Evaluation of Selected Gaseous Halocarbons for Use in Source Test Performance Audits. Journal of the Air Pollution Control Association, 33(9): 823-832, 1983.

Jayanty, R. K. M., C. B. Parker, C. E. Decker, W. F. Gutknecht, Darryl J. vonLehmden and Joseph E. Knoll. Quality Assurance for Emissions Analysis Systems. Environmental Science and Technology, 17(6): 257A-263A, 1983.

Howe, G. B., R. K. M. Jayanty, W. F. Gutknecht and C. E. Decker. Evaluation of Selected Gaseous Halocarbons for Use in Source Test Performance Audits. In: Proceedings of Measurment and Monitoring of Non-Criteria (Toxic) Contaminants in Air Specialty Conference. Air Pollution Control Association, Chicago, Illinois, 1983. pp. 258-267.

Jayanty, R. K. M., W. F. Gutknecht, and E. Y. Baladi. Guidelines for Hazardous Waste Removal and Control at Military Installations. American Laboratory, December 1983.

Jayanty, R. K. M., R. G. Fuerst, T. J. Logan, and M. R. Midgett. A Pill for the Assessment of Pollution Measurement Methods. In: Proceedings of Third Annual National Symposium on Recent Advances in Pollutant Monitoring of Ambient Air and Stationary Sources. May, 1983.

Jayanty, R. K. M., R. G. Fuerst, T. J. Logan, and M. R. Midgett. A New Audit Method for EPA Method 6. Journal of the Air Pollution Control Association. December, 1983.

Selected Publications (Continued)

Jayanty, R. K. M., G. F. Hunt, "Systems and Performance Audit on Pesticide Industry Wastewaters Analytical Data", presented at the 180th American Chemical Society National Meeting, San Francisco, California, August 26-29, 1980.

Gaskill, A., Jr., Gutknecht, W. F., Jayanty, R. K. M., and Lentzen, D. E., "Evaluation of Spark Source Mass Spectrometry in Environmental Assessments". Presented at the 7th Annual Meeting of the Federation of Analytical Chemistry and Spectroscopy Societies, Philadelphia, September 25, 1980.

Gaskill, A., Jr., and Jayanty, R. K. M., "A Quality Assurance Program for Determination of Herbicides in Estuarine Waters". Journal of Environmental Science & Health (1981), B16(4) 453-463 (1981).

Jayanty, R. K. M., and Gaskill, A., Jr., "Use of Reference Materials in a Comprehensive Quality Assurance Program,". Presented by Jayanty at the American Chemical Society Meeting in Miniature at Duke University, Durham, North Carolina, April, 1981.

Jayanty, R. K. M., and Blackard, A., "Determination of the Non-methane Organic Carbon (NMOC) by Cryogenic Preconcentration and Flame Ionization Detection". Poster presentation at the American Chemical Society Meeting in Miniature at Duke University, Durham, North Carolina, April 1981.

Gutknecht, W. F., Decker, C. E., Howe, G. B., and Jayanty, R. K. M., "Laboratory and Field Evaluation of Personnel Sampling Badges and Charcoal Tubes". Presentation at the National Symposium on Monitoring Hazardous Organic Pollutants in Air, Raleigh, North Carolina, April 28 - May 1, 1981.

Jayanty, R. K. M., Gutknecht, W. F., Gaskill, A., Jr., and Lentzen, D. E., "Evaluation of Level 1 Organic Analysis Procedures", presented at the Federation of Analytical Chemistry and Spectroscopy Societies, Philadelphia, PA, September, 1981.

Jayanty, R. K. M., Howe, G. B., Salmons, C., and Gutknecht, W. F., "Laboratory Evaluatin of Charcoal-type, Air Sampler Tubes for Collection of Acrylonitrile at the PPB Level", presented at the National Symposium on Recent Advances in Pollutant Monitoring of Ambient Air and Stationary Sources, Raleigh, North Carolina, May 1982.

Selected Publications (continued)

Jayanty, R. K. M., and Saxena, E. R., "Catalytic Hydrogenation of Cresols to Methylcyclohexanols". Research and Industry, 19, 157 (1974).

Jayanty, R. K. M., Simonaitis, R., and Heicklen, Julian, "The Reaction of NH_2 with NO_2". I.R.L. Report. The Pennsylvania State University (1976).

Gangwal, S. K., Grohse, P. M., Wagoner, D. E., and Jayanty, R. K. M., Measurement Methodology for Low Molecular Weight Sulfur Effluents from a Semi-Batch Coal Gasifier", presented at the 22nd Annual Conference on Analytical Chemistry in Energy Technology, Gatlinburg, Tennessee, October 10-12, 1978.

Gangwal, S. K., Jayanty, R. K. M., Nichols, Duane, Wagoner, D. E., and Grohse, P. M., "A Sampling and Analysis Procedure for Gaseous Sulfur Compounds from Fossil Fuel Conversion." presented at the Oil Shale Sampling Analysis and Quality Assurance Symposium, Denver, Colorado, March 26-28, 1979.

Wongdontri-Stuper, Wanee, Jayanty, R. K. M., Simonaitis, R., and Heicklen, Julian, "The Cl_2 Photosensitized Decomposition of O_3: The Reactions of ClO and OClO with O_3", Journal of Photochemistry, 10, (1979).

Jayanty, R. K. M., Gutknecht, W. F., and Gaskill, A., Jr., "Quality Control/Quality Assurance Practices for the determination of Priority Pollutants in Pesticide Industry Wastewaters", presented at the 178th American Chemical Society National Meeting, Washington, D. C., September 10-14, 1979. (Abstract appeared in the proceedings)

Jayanty, R. K. M., Gutknecht, W. F., Gaskill, A., Jr., and Lentzen, D. E., "Evaluation of Level 1 Analysis Procedures", poster presentation at Second Symposium on Process Measurements for Environmental Assessment, Atlanta, February 25-27, 1980 (Abstract appeared in the proceedings)

Jayanty, R. K. M., and Gaskill, A., Jr., "Quality Assurance Program for Herbicide Monitoring Laboratories", presented at the annual Meeting-in-Miniature of the North Carolina Section of the American Chemical Society, University of North Carolina, April 1980.

Gutknecht, W. F., Gaskill, A., Jr., Jayanty, R. K. M., "Quality Assurance - A Way to Acceptable Analytical Data". Presented by W. F. Gutknecht at the 179th American Chemical Society National Meeting, Houston, Texas, March 24-28, 1980.

Experience (Continued)

1966 to 1969. Regional Research Laboratory. Scientific Assistant. Developed catalyst for hydrogenation of cresols and benzene and tested in pilot plant. Process currently in commercial production.

Professional and Honorary Associations

American Chemical Society
Air Pollution Control Association
Sigma Xi

Selected Publications

Jayanty, R. K. M., Polgar, L. G., Kenson, R. E., "Hydrocarbons Classification, Measurement and Control". Presented at the National Petroleum Refinery Association Meeting, San Francisco, March 1977. (Paper appeared in the proceedings)

Jayanty, R. K. M., Simonaitis, R., Heicklen, Julian, "Inhibition of Photochemical Smog III". Atmospheric Environment, 8, 2383 (1974).

Jayanty, R. K. M., Simonaitis, R., Heicklen, Julian, "The Photolysis of Chlorofluoromethanes in the Presence of O_2 or O_3 at 213.9 mm, and their Reactions with $O(^1D)$. J. Photochemistry, 5, 217 (1976).

Jayanty, R. K. M., Simonaitis, R., Heicklen, Julian, "The Photolysis of CCL_4". Journal of Photochemistry, 4, 203 (1975).

Jayanty, R. K. M., Simonaitis, R., Heicklen, Julian, "The Reaction of $O(^1D)$ with Methane". International Journal of Chemical Kinetics, 8, 107 (1976).

Jayanty, R. K. M., Simonaitis, R., Heicklen, Julian, "Reactions of Electronically Excited $O(^1D)$ Atoms with Halocarbons". Journal of Photochemistry, 5, 217 (1976).

Jayanty, R. K. M., Simonaitis, R., Heicklen, Julian, The Reaction of NH_2 with NO and O_2". Journal of Physical Chemistry, 5, 443 (1976).

Jayanty, R. K. M., and Bickley, R. I., "Photoadsorption and Photocatalysis on TiO_2 Surfaces". Discussions of Faraday Society, 58 (1974).

Jayanty, R. K. M., and Bickley, R. I., "Characterization of Surface Groups on TiO_2 by Linear Temperature Programmed Desorption Using Mass Spectrometry". Discussions of Faraday Society, 58 (1974).

R. K. M. JAYANTY

Education

M. Eng., Environmental Pollution Control, Pennsylvania State University, University Park, Pennsylvania, 1975
Ph.D., Physical Chemistry, University of Bradford, Bradford, England, 1972
M.S., Andhra University, Waltair, India, 1966
B.S., Andhra University, Waltair, India, 1964

Experience

1978 to date. Research Triangle Institute. Senior Environmental Chemist. Developed sampling methods and measurement techniques for trace organics and low molecular weight sulfur compounds. Developed a method for the determination of non-methane organic carbon (NMOC) in ambient air by cryogenic preconcentration and flame ionization detection. Participated in Level 1 Environmental Assessment Program. Initiated a program for the validation of QA and QC procedures for sampling and analysis of priority pollutants in industrial effluents. Coordinated for SF_6 tracer analysis audit procedures for the EPRI Plume Model Validation Program. Participated in the analysis and interpretation of chemical data collected in both field studies and smog chamber studies. Recently initiated sampling, analysis, and disposal of hazardous waste materials under the regulations of Resource Conservation and Recovery Act (RCRA). Coordinated the development of hazardous waste management plans and training program at the Pope and Seymour Johnson Air Force Bases.

1976 to 1978. The Research Corporation of New England. Research Scientist. Responsible for direction of laboratory studies on the formation of sulfates and photochemical oxidants. Evaluated feasibility and economic-cost/benefit relationship and hydrocarbon control methods for paper coating industry. Developed sampling methods and analytical techniques for airborne and waterborne toxic pollutants. Assessed significant pollutants in air, water and solid waste from pharmaceutical industry and evaluated associated risk to general population. Initiated and participated in new programs in several areas including air quality monitoring, atmospheric modeling and tracer studies.

1973 to 1976. Pennsylvania State University. Research Associate. Planned and performed research on photolysis of halocarbons in the presence of oxygen and ozone; formulated reaction mechanisms and rate determinations; discovered series of chemical compounds which act as inhibitors of photochemical smog.

1969 to 1973. University of Bradford. Research Assistant and Lab Instructor. Planned and conducted laboratory studies dealing with photoadsorption and photooxidation on titanium dioxide surfaces. Demonstrated that surface hydroxyl groups are responsible for pigment degradation and proposed reaction mechanisms. Developed linear temperature programmed desorption technique using GC/MS for characterization of desorbed species from solid surfaces.

Graduate Research Directed

1. "Application and Theoretical Studies of Silver and Mercuric Sulfide-Based Ion Selective Electrodes," Paul K. C. Tseng, Ph.D., Duke University, April 1977.

2. "An Investigation of the Silver-Cysteine Complex System Using Electrochemical and Spectrometric Techniques," Guan Huat Tan, Ph.D., Duke University, January 1978.

3. "Studies of the Conditioning of Mercuric Sulfide-Based Ion Selective Electrodes in Aqueous Solution," Lois A. Dixon, M. S., Duke University, August 1978.

4. "Gas Chromatographic-Catalytic Procedures for the Determination of Inorganic Ions," Mauri A. Ditzler, Ph.D., Duke University, April 1979.

5. "A Study of Changes in the Physical, Chemical, and Electrochemical Properties of Glassy Carbon with Chemical Surface Treatments," Robert B. Myers, Ph.D., Duke University, April, 1980.

7/81

Miller, D. W., J. P. Sgambat, and Keith Porter, 1978. Regional Ground-Water Quality Monitoring. American Water Resources Symposium Proceedings of Establishment of Water-Quality Monitoring Programs, San Franciso, California, June 12-14.

Sgambat, J. P., Elaine A. LaBella, and Sheila Roebuck. 1980. Effects of Underground Coal Mining on Ground Water in the Eastern United States. EPA-600/7-80-120. Industrial Environmental Research Lab, Office of Research and Development, U. S. Environmental Protection Agency, Cincinnati, Ohio.

Sgambat, J. P., 1979. Confidence in Ground-Water Monitoring. Presented at Geraghty & Miller, Inc., and American Ecology Services, Inc., Conference on Benefiting from Environmental Monitoring, Washington, D. C., October 29-30, 1979.

Jackson, D. A., and J. P. Sgambat, 1980. A Logic for Minimizing Cost and Uncertainty in Solving Ground-Water Contamination Problems: Presented at the National Water Well Association Ground Water Technology Division Education Program, Las Vegas, Nevada, October 8, 1980.

Schultz, M. G., J. P. Sgambat and M. Warfel, 1982. Status of Groundwater Source Heat Pump Applications in the Mid-Atlantic States: Presented at the Mid-Atlantic Energy Conference and Exposition, Baltimore, Maryland, December 9, 1982.

Affiliations

University of Maryland - Instructor of Ground-Water Geology Course - Spring 1980
National Water Well Association, Technical Division
Geological Society of America
Certified Professional Geologist 4932 - American Institute of Professional Geologists (AIPG)
Secetary-Treasurer - Capitol Section AIPG

DON A. LUNDY

Senior Scientist

Geraghty & Miller, Inc.

Professional Qualifications

Don A. Lundy holds a B.S. degree in geology from the University of Texas at Austin (1970) and an M.S. degree in geology, with emphasis in hydrogeology, from the University of Wyoming (1978). He is certified as a registered geologist in the State of California.

Mr. Lundy has ten years of practical working experience in the fields of ground-water hydrology and geology. Prior to joining Geraghty & Miller, Inc., he served with the Peace Corps in India, worked for the U. S. Geological Survey in Wyoming, and was project geologist for Brown and Caldwell Consulting Engineers in California. He has in-depth experience in the planning and execution of ground-water supply, contamination, and computer modeling projects. He has been responsible for supervising site investigations involving test drilling, sampling of contaminated soils, installation of both monitor and production wells, and testing for a variety of hydraulic and water-quality parameters. He has worked with attorneys in developing technical defense strategies for pending law suits. In addition, he has assisted the U.S. EPA with the resolution of selected groundwater issues that effect RCRA regulations.

<u>Experience with Geraghty & Miller, Inc.</u>

1981 Supervised soil and ground-water sampling near an industrial landfill leaking PCB-contaminated waste oils. Developed and evaluated four alternative plans to remedy the leakage problem.

Reviewed proposed EPA regulations governing disposal of hazardous materials to land for American Petroleum Institute in Washington, D. C. Prepared extensive technical comments focusing on difficulties with practical implementation of the ground-water sections of these proposed regulations.

Managed a ground-water field investigation at two industrial landfills containing aluminum chloride which is potentially explosive in the presence of water. Developed quarterly ground-water monitoring

programs to be implemented by the client with assistance from a local laboratory.

1982 Developed cost models for containment of subsurface contaminant plumes by recovery well/fluid treatment systems. Worked with outside economists performing cost/benefit studies for EPA.

Served as technical reviewer providing outside opinion on remedial action taken at a site in California. Evaluated recovery-well control of a plume containing industrial solvents.

Managed a review of technical documents and the development of a technical defense for 30 defendants under suit for illegal dumping of hazardous wastes into a municipal landfill.

Managed a project for EPA that involved the resolution of selected technical issues regarding disposal of hazardous wastes into saturated low-permeability earth materials.

1983 Managed an EPA project that used transport models to evaluate locational factors and selected design standards as related to siting of hazardous-waste facilities.

Publications and Presentations

Lundy, Don A., 1978. Hydrology and Geochemistry of the Casper Aquifer in the Vicinity of Laramie, Albany County, Wyoming. Univ. Wyo. Water Res. Research Inst. 76 pp. (also published by NTIS, publ. PB-291 546/OWP).

Huntoon, P.W., and Don A. Lundy, 1979. Fracture-Controlled Ground-Water Circulation and Well Siting in the Vicinity of Laramie, Wyoming, Ground Water, vol 17, no 5.

Huntoon, P.W., and Don A. Lundy, 1979. Evolution of Ground-Water Management Policy for Laramie, Wyoming, 1869-1979, Ground Water, vol 17, no 5.

Lundy, Don A., and D.L. Erikson, 1980. Methods for Sampling Soils and Ground Water Contaminated by Hydrocarbons, presented in Las Vegas at the National Water Well Association's Annual Water-Quality Symposium.

Lundy, Don A., and William S. Stevens, 1982. Simple Models for Estimating the Number and Discharge of Wells for Containment of Groundwater Plumes, presented in Atlanta at the National Water Well Association's Annual Water-Quality Symposium.

Lundy, Don A., and Jeffrey S. Mahan, 1982. Conceptual Designs and Cost Sensitivities of Fluid Recovery Systems For Containment of Plumes of Contaminated Groundwater, Proceedings of the National Conference on Management of Uncontrolled Hazardous Waste Sites, Hazardous Materials Control Research Institute, Silver Spring, Maryland, pp. 136-140.

Affiliations

Member of National Water Well Association, Technical Division

CLEASON P. SMITH

Staff Scientist

Geraghty & Miller, Inc.

Professional Qualifications

Cleason P. Smith is a staff scientist with the firm of Geraghty & Miller, Inc. He holds a B.S. Degree in Geology from California State College of Pennsylvania and a M.S. Degree in Geology from West Virginia University; in the Masters program at W.V.U., Mr. Smith specialized in geochemistry and hydrogeology.

Graduate research studies conducted by Mr. Smith dealt with (1) the rates and degree of neutralization of acid mine drainage in polluted West Virginia streams, and (2) the characterization and assessment of deep-mine effluents draining from abandoned Pittsburgh and Sewickley coal mines. The latter study focused on the effectiveness of natural processes in improving the quality of acid mine drainage over time. Following completion of his M.S. program, Mr. Smith worked on a research grant, through W.V.U., that assessed the effects of coal mining on groundwater quality in West Virginia.

Geraghty & Miller, Inc., Work Experience

1979- Worked on the EPA Underground Injection Control Project developing a summary and comparison of existing state and Federal regulations governing Class III wells.

Conducted field investigations, supervised auger drilling programs, and evaluated field data for hazardous-waste disposal site permits at several different sites in Maryland.

1980- Supervised acid rejuvenation and redevelopment of iron-encrusted fire protection wells at a site in Missouri.

Supervised mud-rotary drilling, installation of deep monitor wells, and sampling of groundwater contaminated by organic chemicals at a site in Tennessee.

Supervised the installation and development of monitor wells and recovery wells in an effort to identify and control a plume of organic chemical contamination in Texas. Also evaluated the rate of movement, extent of migration, and effectiveness of controls on this body.

1981- Supervised the installation of a french drain collection system at a petro-chemical plant site in South Carolina. This system was designed to control the migration of contaminated groundwater from existing surface impoundments.

Project manager of a study to evaluate the degree and extent of migration of contaminants from abandoned chemical-waste lagoons at a site near Reading, Ohio. This study included the design and installation of a comprehensive groundwater monitoring network, evaluation of hydrogeologic and water-quality data, and the conceptual design of a groundwater collection system that could be utilized to abate existing contamination problems.

Principal investigator in the EPA funded, mine-site study designed to assess impacts on groundwater quality that have resulted from solid waste-handling practices. The first phase of this study involved site inspections and evaluations of existing hydrogeologic data, design of appropriate groundwater monitoring systems, and assessments of potential monitoring problems associated with each site. Later phases of the study included installation of monitor wells, interpretation of hydrogeologic and water-quality data, and assessment and summary of the degree and extent of groundwater contamination resulting from waste-handling practices.

1982- Project manager of an investigation designed to determine the nature and extent of groundwater contamination emanating from multiple source areas within a chemical manufacturing plant located in the Ohio River Valley of West Virginia. The study included delineation and mapping of contaminant plumes, and conceptual designs for a system of gradient control wells to abate water-supply problems related to groundwater contamination.

Project manager of a study to define groundwater flow patterns, water-quality trends, and aquifer hydraulic characteristics at a municipal landfill site in eastern Virginia. The study resulted in the granting of a landfill expansion permit from state regulators.

1982- 1983 Project manager of an Installation Restoration Program (Phase II) conducted at an air force base located in northeastern South Carolina. The study was designed to assess the nature and extent of groundwater contamination resulting from fire training exercises, fuel spills, and other practices that have been routinely conducted by the Air Force. Appropriate remedial measures for monitoring and abating contaminant-related problems were evaluated.

1983 Project manager of a two-part study to 1) investigate the effects of fly ash disposal on groundwater quality, and 2) evaluate aquifer hydraulic properties and design a system of wells to control hydraulic gradients at a site located in the Ohio River Valley of West Virginia.

Project manager of a study to determine aquifer hydraulic properties and assess the occurrence and movement of groundwater beneath a site in central North Carolina.

Publications and Presentations

Smith, C. P., and H. W. Rauch, 1980. Factors Affecting the Chemistry of Acid Mine Drainage. Presented at the American Geophysical Union Conference, Toronto, Canada, May 22.

Smith, C. P., and H. W. Rauch, 1980. Factors Affecting the Chemistry of Acid Mine Drainage. Presented at the National Water Well Association Convention, Las Vegas, Nevada, October 8.

Affiliations

National Water Well Association (Technical Division)
American Geophysical Union
Sigma Gamma Epsilon
American Institute of Professional Geologists (Associate Member)

JOHN R. MILDENBERGER

Scientist

Geraghty & Miller, Inc.

Professional Qualifications

John R. Mildenberger holds a B.S. degree in Geology from the University of Maryland, College Park, Maryland. Prior to joining Geraghty & Miller, Inc., in November 1981, Mr. Mildenberger was employed by Pittsburgh Testing Laboratory for two years. Mr. Mildenberger acted as Administrative Assistant to the Baltimore District Manager, and was involved in numerous geotechnical investigations.

Mr. Mildenberger's responsibilities at Pittsburgh Testing Laboratories included preparation of drilling and geotechnical reports, logging of numerous borings, and installation of monitoring wells. In addition, he has experience in the soils laboratory and structural fill placement.

Since joining Geraghty & Miller, Inc., Mr. Mildenberger has participated in extensive field programs, general research, data collection, and basic analytical tasks. He has been responsible for the installation of several ground-water monitoring programs and the sampling of these sites.

For EPA, Mr. Mildenberger has performed an analysis of general aquifer flow properties of surficial geologic units. Activities have included basic hydrogeologic computations and data reduction. He has also participated in data collection and report writing for a DOD Installation Restoration program.

ROBERT L. WRIGHT

Scientist

Geraghty & Miller, Inc.

Professional Qualifications

Robert L. Wright holds a B.S. degree from Westminster College in Biology and a M.S. degree from Drexel University in Environmental Science with concentrations in Environmental Chemistry and Water Quality Resources. Prior to joining Geraghty & Miller, Inc., and during his graduate education, Mr. Wright was employed by Drexel University Environmental Studies Institute working in the trace organics laboratory on a research project concerning BAC-Ozonation processes in water treatment.

During employment with Geraghty & Miller, Inc., Mr. Wright has been involved in many aspects of groundwater work. He has experience in groundwater contamination monitoring including monitor well installation, sampling procedures, and interpretation of water-quality data. Mr. Wright has supervised and participated in many contamination studies which included drilling and sampling programs. He also has experience in the use of various analytical and numerical computer models to simulate groundwater flow and contaminant transport.

Geraghty & Miller, Inc., Work Experience

Managed a groundwater monitoring and evaluation program for a chemical manufacturing plant in West Virginia.

Participated in several projects providing technical support to the EPA which involved computer groundwater transport models, possible groundwater treatment processes, and cost estimation.

Conducted a field investigation including sampling and using a Portable Organic Vapor Analyzer-Gas Chromatograph to estimate volatile organic contamination in South Carolina.

Participated in an groundwater investigation of a diesel fuel spill in Nebraska which involved delineation and suggested remedial action.

Performed groundwater flow computer modeling for a proposed municipal water supply in Western Virginia.

Conducted a study of possible groundwater contamination resulting from land disposal of municipal sludge in Nassau County, New York.

Supervised a sampling team for a project examining the groundwater contamination from mine tailings dams throughout the U.S.

END

FILMED

8-85

DTIC